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The Institute of Vitreous Enamellers

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and

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More Statistics

When, some seventeen years ago, we became responsible for the editorial conduct of this JOURNAL, the statistical position of the foundry industry was definitely chaotic, and whilst perfection in presentation has not yet been reached, the level attained is highly satisfactory, and, more, the detailing is progressively improving. For instance, the malleable trade figures are intelligently dealt with in the Census of Production which we abstracted last week, and tube fittings are now clearly separated from the balance. There are still, however, too many figures intermixed with the steel trade, and such items as fencing materials, railway materials and the like demand a further sub-division in order to isolate the foundry industry from wrought products. On the other hand, the position of the non-ferrous industry is still masked by its inclusion with smelting and rolling.

After all, it is of no benefit to the Government officials to take isolation of trades and industries to the extreme, as we feel certain that all they desire is important sectionalisation and broad assembly under as few heads as possible. From the foundryman's angle, it is obviously desirable to coalesce all the sections of the industry statistically in order that he may acquire for it the recognition it warrants as a great basic industry; that it may be considered adequately when changes in industrial legislation are envisaged, and that it may ensure for itself a proper recognition when the consensus of opinion of the great basic industries is sought. Such conditions usually arise in times of national emergency. It is a cause for some congratulation that, on the whole, the exports of foundry products, as consumable goods, are far greater than the imports, the principal exception being that of bath tubs.

An interesting phase of these Census of Production figures is the correlation of pig-iron purchases, foundry pig-iron production and make of foundry iron compared with total production. It appears that the foundries use just over one per cent. more than the production of foundry pig-iron, the figures for 1934 being 1,275,500 tons of foundry pig-iron made and 1,334,600 tons of all grades of pig-iron used. The figures for 1935 were 1,325,800 and 1,424,500 tons respectively. In the former year, the proportion of foundry pig-iron to the total production was 21.3 per cent., and in the latter 22.6 per cent. This means broadly that for the two years under consideration the foundry industry was slightly more active than the steel trades. Another interesting figure brought to light is that bought scrap, including steel, is 624,000 tons, or well under half that of pig-iron. The consumption of coke—458,300 tons—reveals that the industry is working reasonably economically, if auxiliary coke can be set off against melting furnaces using other types of fuel.

The Foundry and the Building Industry

Building construction has recently reached a record level, and the exhibition closing to-day at the Building Centre in Bond Street, London, illustrates comprehensively the relation of science to building. It is estimated that the country has four and a-half thousand millions sterling invested in buildings, and each year sees £150 to £200 millions spent on new construction apart from expenditure on repairs and maintenance. The principal section of the industry with which we are concerned is, of course, that dealing with light castings, both for external service, such as rain water pipes and gutters, traps and covers, and for internal service for the multitudinous applications such as gas and electric stoves and cookers, coal and coke grates, radiators, baths, hollow-ware, and so on. This is the field in which enamelling has made such great strides in recent years. Malleable iron also finds important applications in building construction. If the field of building construction be taken to cover the wider area of public works in which architects, surveyors and contractors are interested, including pipe lines, roads, and so on, the amount of foundry products concerned becomes formidable. Non-ferrous interests come in also on brasses and bronzes, and not least in finishes such as chromium plating, while there are in special cases applications of steel castings, including stainless steel. Thus the building industry draws on the whole range of foundry products, and any scheme which makes it easier for architects, surveyors and builders to know what is available is to be commended.

Figures given by the Fuel Research Station with respect to the efficiency of the open fire are of interest. The most suitable and economical design has been worked out. In an experimental grate the radiant efficiency of the fire varied with coal from 19 to 24 per cent., while with low temperature coke the efficiency rose to 33 per cent. The air supply to the fire does not affect the efficiency but the rate of combustion, and the grate should really be designed to suit the fuel used, for a free-burning fuel needs less draught. These facts explain the changes and improvements in open grates now available and which have become familiar through the British Industries Fair and other exhibitions.

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London Foundrymen's Visit to Belgium

Headed by their Branch-President, Mr. V. Delport, about twenty members of the London Branch of the Institute of British Foundrymen last Wednesday week crossed over from Harwich to Antwerp with the object of visiting a number of representative Belgian foundries. The programme had been carefully chosen to include every phase of foundry practice—roll making, heavy engines, light stove work, steel, ingot moulds, chilled car wheels, non-ferrous, light alloys and die castings.

* * *

The party was met at Harwich by Mr. H. W. Lockwood, the indefatigable honorary secretary, Mr. C. H. Kain and Mr. Tibbenham, Jun. An unexpected visitor was Mr. Paul Fassotte, who happened to be returning to Brussels with a particularly nice sporting dog. Mr. S. H. Russell, of Leicester, a Past President of the Institute, was also a member of the party.

* * *

On arrival at Antwerp, the party was met by Mr. Paul Ropsy, Mr. Arnold Carr and Mr. John Shaw. Here the party divided into two sections, the major part visiting the works of the Société Anonyme Belge Griffin, which specialises in the production of heavy chilled castings. The smaller party, under the leadership of Mr. V. C. Faulkner, went to the non-ferrous foundry department of Schippers, Podevyn Company at Hoboken. Here they were received by Mr. Knorsch and were first shown the casting of rods by a centrifugal process in a machine designed and manufactured by a Manchester firm. London-made furnaces were extensively used for the melting of the metal. An interesting department was that devoted to the manufacture of cold brass stampings, using German machines for their production. The die making department was of particular interest, as it catered also for the die castings machines inspected later. In the light alloy shop some very large Alpax channel-like castings were being made. An outstanding speciality is the manufacture of aluminium alloy die-castings and for certain jobs it is necessary to assemble as many as nine men around the machine. This is indeed a monument of organisation. The last machine to be inspected was the Polak pressure die casting machine. Whilst at that time it was operating on a light alloy metal, it does, quite often, manufacture castings from heavy non-ferrous alloys.

* * *

The two parties met at the Central Station and proceeded by motor coach through Malines to Brussels, where lunch was taken at the Albert I Restaurant. The afternoon was devoted to visiting the "Fonderies Nestor Martin," extended reference to which was made when we reported the works visits held in connection with the International Foundry Congress held in Belgium a year ago last September. The foundry, it will be recalled, manufactures large quantities of vitreous enamelled cooking stoves. There was just time to call at the offices of Pittevil & Company for a cocktail before taking the train for Liége.

* * *

Last Friday morning was taken up with a visit to the foundries of John Cockerill & Company. Acknowledged to be one of the best laid-out shops in Europe, the visitors had plenty of time to examine in detail the making of moulds, usually in dry sand, for large iron castings, and the steel and non-ferrous foundries. A fully illustrated description of these works has previously been printed in our columns. After a luncheon at the Café de la Gare, at Seraing, where the Londoners were the guests of the local foundrymen, a visit was paid to Esperance Longdoz, where they were personally escorted round the foundry by Mr. J. Varlet, an honorary member of the Institute. There are a number of striking features about this foundry which make it outstanding in technical circles. There is, for instance, an extensive resort to a 900 calories mixture of blast-furnace and coke-oven gas for melting, heating and drying purposes. Apparently it costs about one-sixth the price of local coke, and it gives advantages in mould drying by suppressing the "sulphur" deposit on the surfaces of moulds. Yet because disadvantages have been encountered with it as a medium for melting in the reverberatory furnace, a pulverised fuel system has been incorporated. By this means the silicon losses have been kept within very reasonable proportions. It will be remembered also that the heat from ingot mould castings is used to dry the cores of the next batch to be made. Some of the visitors were impressed with the use of very hard dry sand for moulds which would normally be made from loam in this country. The local moulders are obviously very high grade craftsmen.

* * *

In the evening the visitors were the guests of Mr. Bougeroff, Mr. Monseur, Mr. Foulon, and other prominent personalities in Belgian foundry circles at the Boulevard restaurant. It was, as was every other aspect of the visit, quite informal, and throughout the tour there was a happy intermingling of hosts and guests.

* * *

Saturday morning—a beautiful spring-like day—was devoted to an inspection of the Fort de Loncin, which was the most outstanding amongst the Liége forts in offering a heroic resistance to the German advance in 1914. As guide the party were particularly fortunate in securing the services of Capt. Demoisseaux, who as a boy of seventeen served throughout the attack. The Captain described how the fort was still in action after the city of Liége had been captured, and guns set up in the main boulevards of the town sent a shell at the back of the fort, which caused the ammunition magazine to explode. This wrecked the whole armament of the fort, and but few were left to surrender. The Captain, however, managed to escape, with Mr. Monseur's father, who was badly wounded, made his way to England, and rejoined the colours.

* * *

It was unquestionably one of the most delightful excursions ever undertaken by foundrymen "on tour." That day the visitors were priviledged to entertain a few of the Belgian foundrymen who had acted as such charming hosts. Amongst those who were present was Mr. Leonard, President of the Association Technique de Belgique, who had been instrumental in arranging the works visits, Capt. Demoisseaux, Mr. Varlet, Mr. Bougeroff and Mr. Monseur. Mr. Delport took the opportunity of thanking them, Mr. Foulon, and the directors and managers of the various establishments visited.

* * *

The return journey served to cement the friendships created during the visit, and but few of the party were willing to retire, in spite of the fact that travelling *via* Harwich means early morning tea at about half-past five. Pleasure was expressed on all sides at the arrangements which Mr. Lockwood had made.

LONDON FOUNDRYMEN TAKEN DURING A VISIT TO THE FORT OF LONCIN, LIÉGE, LAST SATURDAY.

Coulabilité and Life

We have recently had some correspondence with Mr. Ronceray on the subject of nomenclature and its origination. We print below some abstracts from a letter which throws some light on the subject. We have on several occasions stated that it was our belief that Mr. Ronceray invented the French word coulabilité during a motor drive to his works about 1923, as the French word "vie"—the equivalent of the foundry term "life"—rightly sounded ridiculous to his ears. Now Mr. Ronceray writes:—

"I can assure you that I did not invent the word 'coulabilité.' I believe it was Portevin, though I am not quite sure, but the fact is that he used it in his lessons at the first session of the Foundry High School that I founded in 1924. At this time only the spiral tests of the Japanese scientists Saïto and Haijaschi and Remy of Liége were known. Thinking that if the idea was good, the realisation needed to be improved, I recommended my pupil Charles Cury to select the study of this problem for his final examination, with the hope of finding a better and more reliable arrangement. The research was made in the foundry of my company, and under my supervision and advice, so I am quite sure of what I say, and the work was discussed by the examining board at the end of July, 1924.

"The word 'coulabilité' may sound wrong to British ears, *who have the word 'life' to express the same idea*, but I believe that the French word was very likely coined by Portevin. In any case, he did excellent work to develop this idea for which the foundry world may thank him. The only words I coined at about this time were, 'the effet Leonard' and 'the effet Custer.' They perhaps are not very good, but I had to teach at this time foundry defects that were practically unappreciated, and I had no other alternative than to find words to express these defects."

We have italicised Mr. Ronceray's views as to how the word "coulabilité" should be rendered into English, and we now hope to see such awkward words as castability, flowability, fluency, and especially coulability, disappear entirely from the English language.

Double-Drum Winding Engines for Canada

We illustrate a pair of double-drum winding engines which have just been built by John Wood & Sons, Limited, Wigan, for service at a Canadian mine. The full depth of the shaft served is 865 ft. Winding is from two levels, the net loads being 7,000 and 8,500 lbs. coal and stone respectively. The engines for their size are of very massive proportions. The cylinders are 26 in. dia., the stroke 60 in. and the drums 12 ft. dia. by 3 ft. 6 in. wide between cheeks. The cylinders have side branches cast on, machined to receive the valve chests, the front covers of the cylinders being provided with stuffing boxes and "Universal" metallic packings.

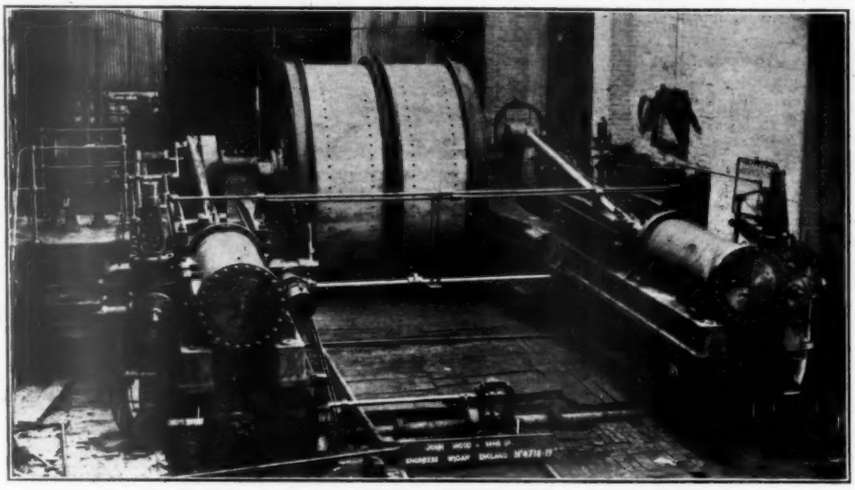

Fig. 1.—General Arrangement of Double-drum Winder.

The valve gear is of the double-piston type, the cut-off being regulated by a drop valve mounted on the same valve chest. The valve chests are fitted at the front end with metallic packing, and with a dummy gland in the back cover. The piston valves of cast iron are each fitted with locked ring, and work in renewable seats secured in the valve chest.

The cut-off valve is of the equilibrium type, with valve and seating of hard cast iron, fitted with air-cushion dashpot and springs, and actuated by valve gear of the builders' improved type, which is under the control of the governor. The drop-valve spindles are also fitted with metallic packing.

The reversing motion is of the "Gooch" type, the mild-steel links being machined all over and supported by substantial brackets to receive the cast-iron slide blocks. The reversing shaft, 4 in. dia., is carried in pedestals underneath the bedplate. The engine motion is worked by a steam reverser, the steam cylinder being 6½ in. dia. and the oil-cataract cylinder 4 in. dia. The engine is controlled by a floating gear coupled to the reversing lever, and so arranged that the position of the reversing link block corresponds to the position of the reversing lever.

The engine pistons are cast iron, and are fitted with Ramsbottom cast-iron rings. The piston rods are of forged steel, 5 in. dia. The forged-steel crossheads of the "jaw" type were machined out of the solid and bored for the reception of the piston rods and crosshead pins.

The connecting rods, 15 ft. long from centre to centre, are fitted with brass steps at each end. Crosshead ends have straps with screw gib and cotter. The crankpin ends are of the solid type, with cotters and bolts. The bearings for the crankshaft are of the four-part adjustable type, with cast-iron steps lined with white metal. The drum shaft is a steel forging, machined all over to 15 in. dia., turned down to 14 in. for the bearings, and with a square part forged on and machined for the clutch to slide on. The shaft has a 2½-in. hole bored for its full length.

The clutch is of cast steel of the multiple-tooth type, 7 ft. 6 in. dia., constructed in halves with machine-cut teeth of 2-in. pitch and 6-in. face. The clutch is bolted and hooped together. The clutch ring, also of cast steel, is securely bolted to the side of the loose drum. The clutch is operated by an engine having steam and oil cataract cylinders mounted on a common bedplate, secured to the engine bedplate. The steam cylinder of the clutch engine has a piston valve, with floating gear controlled by hand lever on the driver's platform. Locking gear is provided, and is arranged for operation by the cage keps lever. This provision makes it impossible for the clutch to be disengaged unless the keps are under the cage at the pit top.

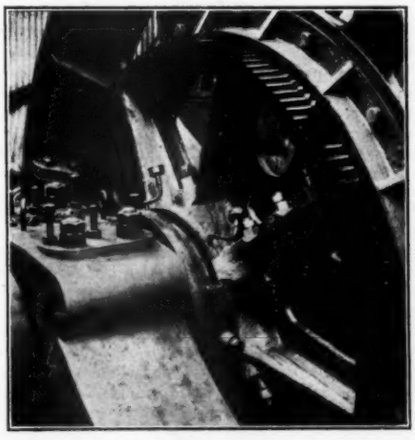

Fig. 3.—Multiple Tooth Clutch taken from Engineman's Platform.

The drums, as already stated, are each 12 ft. dia.; they are constructed of massive cast-iron sides made in halves, with planed joints. A brake ring is cast on one side of each of the drums, turned on the rim and fitted with cast-iron cleads, with ventilation spaces between the cleads and brake ring. Each of the sides of the loose drum is bored and keyed on to a cast-iron sleeve, made in halves, bushed with brass and bored for running loose on the shaft. A facing is cast on one side to receive the clutch ring. The drums are lagged with ⅝-in. mild-steel plate and finished with oak lagging 4⅜ in. thick mounted thereon.

The brakes are of the vertical post girder type, and the cast-iron brake blocks are lined with asbestos fibre. The brakes are arranged to be operated from the driver's platform by foot-controlled steam brake. Upon the platform there is also a hand-wheel and screw to apply the brake to the loose drum when changing the depth of wind. The steam brake is of the vertical type, with a steam cylinder 6½ in. dia. by 12-in. stroke. It is fitted with piston-valve-operating gear, and also with quick and slow braking device actuated by the "Visor" overwind prevention gear. The cast-iron oil-cushion cylinder is 4 in. dia., and is furnished with adjustable regulating plugs.

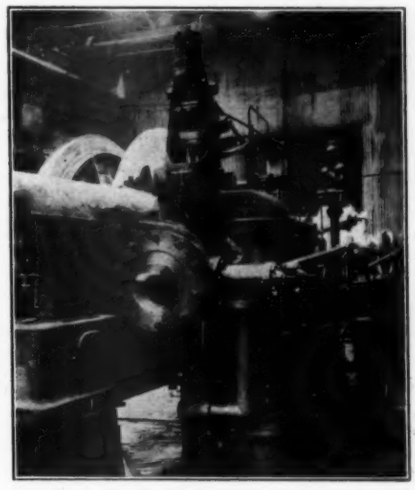

Fig. 2.—Outer Side of Engines showing Valve Gear, Cut-off Valve, etc.

The depth indicator is of the vertical double-pillar type, the travelling pointer of one pillar being geared from the crankshaft, and the second pointer driven by chain and bevel-gear drives from the loose drum. The "Visor" overwind preventers, one for each drum, are positively driven from their respective drums.

The complete assembly is mounted on cast-iron beds of box section, 16 in. deep, with facings cast on and machined for the cylinder feet, slide bars, drag shaft, fenders, etc. Each bed has also a massive crown bracket cast on for the bolting thereto of the flange of the cylinder.

Notes from the Branches

Wales and Monmouth Branch.—Prior to the annual meeting at Cardiff on March 20, a visit was made to the Dowlais Works of British (Guest, Keen, Baldwins) Iron & Steel Company, Limited. After the inspection of the works, tea was taken in the canteen of John Williams & Sons, Limited, at East Moors. The outstanding features of the annual report, which was presented by the honorary secretary, were the recent inauguration of the Bristol Section, and a 30 per cent. increase in membership during the year. Mr. S. Southcott was re-elected Branch-President, Mr. McClelland hon. secretary, and the three new Branch Council members appointed were Mr. T. D. Richards, Mr. R. J. Richardson, and Mr. H. J. V. Williams. Mr. Richardson was appointed delegate to the General Council of the Institute, and he and Mr. Ben Hird were appointed representatives of the Branch on the Technical Committee of the Institute. Mr. McClelland, on behalf of the members, made a presentation to Mr. Ben Hird, who is now managing a foundry at Stamford.

Heat-Treatment of Steel Castings

NOTABLE EXCEPTIONS TO STANDARD PRACTICE

At a recent meeting of the Sheffield Branch of the Institute of British Foundrymen, DR. ROBERT HUNTER, Ph.D., B.Sc., read a Paper "The Heat-Treatment of Steel Castings." This was published in our issues of March 11 and 18, and the discussion which followed the presentation of the Paper is printed below.

Melting Furnaces

MR. J. ROXBURGH (Branch-President) said he himself was concerned with iron foundry practice, but he felt that Dr. Hunter had dealt with the technical aspect of the heat-treatment of steel castings in a very practical manner. It would appear that the heat-treatment of steel castings had been developed to a remarkable degree, and those who were engaged in the iron foundries could learn much. The steel metallurgist seemed to be able to refer very frequently to his iron-carbon diagram, but unfortunately in the iron foundry a diagram for almost every composition of iron would be required. In regard to the annealing of steel castings and the length of time involved, he wondered in the case, say, of an anvil block or a casting of large section, how long it would be necessary to anneal it. He wished to know what type of furnace had been used for melting the various steels reviewed in the Paper.

DR. HUNTER said it was difficult to give a definite length of time for annealing a casting up to, say, 2 ft. in thickness, because it depended solely upon the nature of the casting.

In regard to melting furnaces, alloy steels could generally be manufactured in the same type as used for mild steel castings. The nickel and low-alloy steels were usually made in an open hearth or electric furnace, but the high-alloy chromium compositions were practically always made in the electric-arc or high-frequency furnaces.

Heat-Treatment of Carbon Steels

MR. T. R. WALKER asked for more information, if possible, on the treatment of carbon-steel castings. Some foundries did make manganese steel, stainless steel, alloy or other steels, but most foundries manufactured carbon-steel castings. He would also like information about the rate at which it was permissible to heat castings for annealing. Time was money, and if time could be saved in the heat-treatment of castings, so much the better. In the case of a casting of 4-in. section, at what rate in degrees per hour would it be permissible to heat the casting? Was it advantageous to soak the casting for the necessary time of one hour per inch of section, then remove it from the furnace, allow it to cool to 400 or 450 deg. C., and put it back in the furnace for tempering? Further, supposing it was then heated to 650 deg. C. for tempering. It would, of course, have to cool, and to what temperature should it be cooled in the furnace before it could safely be taken into the shop? Should it remain in the furnace to cool slowly until it was quite cold, or could it be removed, releasing the furnace for something else? In many foundries the heat-treatment of castings was carried out as a more or less continuous process in a three-chambered furnace. The first chamber was used for preheating, the second for soaking, and the third for cooling off. Usually, and they ought to be, castings were from the same cast, or at least were of the same composition. If all the castings were given the same treatment whether they were 1-in. sections or 4-in. sections, would it do any harm? Would the time fixed for the 1-in. section be inadequate for the 4-in. section?

Temper Brittleness

DR. HUNTER replied that the rate of heating to be applied for a 4-in. section would generally be about one hour per inch of thickness; *i.e.*, in a normally constructed furnace it would take about 4 hours to attain the necessary temperature. Usually a foundry was dealing with 3 or 4 tons of castings at a time, and it took about 9 or 10 hours to attain the annealing temperature. As a rule, it was not convenient to charge the castings directly into the furnace at the annealing temperature. He would not say there was a maximum rate of heating, because that depended so much on the shape and composition of the casting. With reference to Mr. Walker's question of the air-cooling of a casting to 400 or 500 deg. C. and then returning the casting into the furnace, he saw no reason why that should not be done. The advisability of cooling in the furnace from the tempering temperature depended on both the composition and the type of casting. Certain compositions must not be cooled slowly in the furnace; for example, nickel-chrome steel tended to exhibit the undesirable feature of temper-brittleness. The advantage of cooling in the furnace was that the casting would be much freer from stress than it would be by any other means. This might be an important consideration. If a steel that could be cooled in the furnace was wanted, one would have to use a composition that was not subject to temper-brittleness. Regarding the heat-treatment of castings of different sections, the common practice was to give a casting the heat-treatment necessary for the thickest section.

Stress Relief

MR. R. C. TUCKER said he was interested in the temper-brittleness of nickel-chrome steel castings. He had had occasion to test some small castings supposedly of the composition and heat-treatment mentioned by Dr. Hunter. He cut pieces from these castings and found Izod values of 1 ft.-lb. When he rejected the castings he was told by the steel founder that a cast-on test-bar would have given good Izod values. He maintained that this was not true, and that where pieces could be trepanned they gave a much better indication than cast-on test-bars which often caught the dirt.

He was very much interested in Dr. Hunter's remarks about stress relief, because many of the members present were more concerned with cast iron, which was a brittle material at any temperature. It was a surprise to hear that steel at high temperatures was just as brittle as cast iron. Much work had been done on the brittleness of cast iron and steel during the last few years because of the difficulty in which the steel founder found himself. The surprising thing was that he was surmounting the difficulties so well.

They were forced to the conclusion that cast iron bore some relation to cast steel for it had been shown that similar treatment would benefit both alloys. Regarding Dr. Hunter's remarks about the physical condition of manganese steel, he agreed that the preparation of test-pieces was an arduous procedure in normal machine-shop practice, but he saw no reason why manganese steel should not be ground finished with the modern methods available in industry. If manganese steel was required to stand certain tests more than a Brinell hardness test should be demanded, as this was very deceptive on such steel. A certain amount of ductility should be asked for in the body of the steel. Manganese steel was only a suitable material under abrasive conditions. As regards mere fractional resistance, manganese steel showed no advantage over some of the other alloy steels mentioned by Dr. Hunter.

Caterpillar Shoes

DR. HUNTER was pleased to learn that Mr. Tucker's experience of stress relief with cast iron had confirmed what he himself had mentioned. He supposed that steel and iron were related in that way, and that it was the carbon that constituted the greatest difference. For practical purposes, he thought, the preparation of manganese steel test-pieces was not worth the trouble. The Brinell test was usually taken to satisfy the inspector. If they wanted to use manganese steel under conditions of severe stress then a tensile test was justified, but as a rule this steel was wanted to resist abrasion accompanied by pressure. A more practical test would be to have some arbitrary standard wear test based on service requirements. In regard to a suggestion that steel was too ductile, he supposed that it was meant that it had too low a yield point so that in service stretching occurred. That might take place, for instance, in caterpillar shoes, where the stretching might throw the shoes out of pitch.

Art or Science?

MR. TUCKER asked Dr. Hunter if he would say that the heat-treatment of steel castings was just as much an art as the founding of steel castings.

DR. HUNTER said there was no doubt that the manufacture of steel castings was to a certain extent an art. It was an art that was controlled by science, but as far as the heat-treatment was concerned he would say that it was essentially scientific, and in his Paper he had sought not only to treat it from that angle, but also from a practical point of view. The heat-treatment process could be called an art because certain castings were difficult to heat-treat without cracking. He would say, however, that as a rule the steel founder tried to avoid that trouble. Generally speaking, he would use a more expensive composition to overcome the difficulty. He would say that there was, if anything, more science than art in this aspect, but the point was rather debatable.

Large Anvil Block Practice

DR. C. J. DADSWELL, speaking in regard to the heat-treatment of large anvil-blocks, said that the very largest blocks of the sort made in steel in this country weighed about 100 tons, and that the average time for annealing and tempering was about three weeks. The castings were released from the moulds in about a week or ten days after casting, when they were at about 500 to 600 deg. C. He was not quite sure whether or not Dr. Hunter said that the rate of heating was immaterial, and that one could heat at the highest rate possible in going up to the annealing temperature. At one time the anvil-blocks referred to, which were about 10 or 11 ft. square and 6 ft. deep, were heated at the rate of 5 to 7 deg. C. an hr. and the soaking time was between 50 and 60 hrs. This meant that the casting was in the furnace for over a month. In these days one required the maximum output from all plant including annealing furnaces; although at the same time one could not risk any mishap during annealing as the castings had to be as stress-free as possible, owing to the nature of their subsequent life. Mr. T. F. Russell, of the research department at the author's works, who was a member of the Iron and Steel Institute Committee on Alloy Steel Ingots, read a Paper on the rate of heating for large masses and he had calculated what the theoretical rate of heating and soaking time should be for certain typical shapes, such as these blocks. The result was that the total time of treatment was reduced.

DR. HUNTER, speaking in reference to his previous remarks about the highest rate of heating possible, said the rate of heating was one hour per inch of thickness. This, he emphasised, applied to ordinary castings, and as he had indicated, the rate largely depended on the type of castings concerned. In regard to the length of soaking time in relationship to the thickness of the sections the figures he had given were approximate ones which might be applied in ordinary circumstances, but with a special article like an anvil block, which differed from

the ordinary type of casting, it was permissible to apply different rates. The question of decreasing the total time would depend on the rate of heating, because if the heating was slow there would not be a very great lag in temperature between the centre and the outside of the casting. He presumed that a mathematical calculation could be applied so that the time of heating might be reduced with safety above about 600 deg. C., because steel exhibited a more plastic than elastic nature above this temperature, which would result in a lowering of the thermal stresses involved.

Mr. Tucker asked Dr. Hunter at what temperature they should temper mild steel castings.

Dr. Hunter replied that many mild steel castings could be straightened at red heat and if it was considered necessary the casting could be re-annealed after straightening.

Thermal Conductivity of Austenitic Steels

Mr. E. J. Brown referring to previous speakers' remarks on the rate of heating, suggested that an important point was that the thermal conductivity of austenitic steels was considerably less than that of carbon steels. He believed that in the case of manganese steel it was about one sixth. He had experienced less trouble in rolling manganese steels if they were charged into the annealing furnace with a reserve of heat from casting, as distinct from heating from the cold. With regard to specifications he would not like to be a party to any retrogressive policy, but suggested that a case could be made out for not annealing electric-furnace mild-carbon steel castings, as evidenced by the fact that a 180 deg. bend could be comfortably obtained in the "as-cast" condition.

Dr. Hunter said that as far as the castings dealt with in his Paper were concerned he had refrained from the mention of heat conductivity. For one thing, alloying elements undoubtedly decreased the heat conductivity. He mentioned that stainless steels as a rule only had about half the heat conductivity of ordinary carbon steels.

Vote of Thanks

Dr. J. G. A. Skerl proposed a vote of thanks to Dr. Hunter, Mr. C. D. Pollard seconding, observed that although Dr. Hunter was a scientist he had given a practical Paper and had clearly demonstrated how science should be applied in practice. The vote of thanks was carried and Dr. Hunter briefly replied.

Ideal Compression Curve for Foundry Moulds

Professor N. P. Aksenov, writing in "Liteynoye Dyelo," discusses and criticises Rodehüser's method of deducing the curve representing the ideal vertical distribution of pressure in a foundry mould from the results of experiments in which a cylinder of known weight and area of base was dropped from a given height on to the rammed foundry sand, and the depth of penetration was measured. It is considered that these deductions were based on erroneous assumptions, chief of which is that the foundry sand always exhibits a permanent deformation however small the applied pressure. Ideal compression curves are deduced taking into account the quiescent and turbulent hydrostatic pressure of the molten metal, and various conclusions are drawn from these curves, *inter alia*, that top parts need not be rammed as tightly as the bottom boxes, and that it would appear to be preferable to employ sand throwing machines for filling the bottom boxes rather than jarring machines. In moulding on jarring-squeezing machines, the compression of the surface layer of sand in the bottom part should be much greater than the compression of the surface layer of the top part. This is not merely to prevent sand from falling out when the box is turned over, but also to effect the necessary compression in the lower layers.

Aluminium Consumption

The importance of aluminium to industry continues to show a pronounced increase. The civil and military transport industries are largely responsible for the extended use of aluminium, as it is now being used in increasing quantities by motor-car, aeroplane, ship and wagon constructors. According to estimates prepared by the Deutsche Bergwerkszeitung, the world's consumption of aluminium during 1936 was about 350,000 metric tons, which represents an increase of 43,000 tons (over 12 per cent.) on the 1935 figure, 123,100 tons on the returns for 1934, and 191,600 tons on those for 1933. At 350,000 metric tons, aluminium consumption in 1936 was 74,000 tons higher than the peak figure of 276,000 tons, which was attained in 1929.

Recently the production of aluminium has been commenced by several countries, which hitherto had relied on their imports from other sources for their supplies. The import statistics of the majority of countries not producing aluminium have, however, shown consistent increases for many years past, and it is expected, in view of the increasing use of the metal, that the value of non-European countries' requirements will further advance.

At the present time, Japan, Australia and India are endeavouring very intently to become independent of aluminium imports. Currency devaluations and other monetary and economic factors have in recent years had the effect of restricting the exports of finished products to overseas markets, and thus British producers have been compelled to take additional interest in countries of the Empire, while producers in Germany have entered into a policy of bartering aluminium products for raw materials from overseas countries with considerable success.

The Alais Froges et Camargue concern is understood to have commenced the production of high-purity aluminium by a new process, in which a mixture of aluminium fluoride, sodium fluoride and barium chloride is used as the electrolyte. The anode alloy contains aluminium and 33 per cent. of copper. The average purity thus obtained is said to be 99.99 per cent., while some results showed a purity of 99.998 per cent.

Possibility of Increase in Price

It is generally anticipated that an increase in the price of aluminium will be made in the near future. The quotation is controlled by a European Cartel, and has not been changed for more than four years. The current level is £100 per ton (£105 for small tonnages). A considerable advance was recently recorded in the prices of aluminium scrap, and, as such a move is invariably followed by an increase in the value of new metal, the suggestion that this will be so appears to be well founded. Producers generally are favourably inclined to higher prices. Output quotas also are expected to be raised.

The British Aluminium Company, Limited, are making extensive developments at their works at Lochaber, Scotland, and British output is likely to show a substantial expansion in the future. Last year, production in Great Britain was about 20,000 tons, an increase of 5,000 tons on the previous year's output. World production in 1936, at 358,700 tons, established a new high record, and was almost 40 per cent. higher than the output in 1935.

Increase in Aluminium Workers' Wages

An agreement has been reached between the British Aluminium Company, Limited, and the National Union of General and Municipal Workers and the Transport and General Workers' Union, whereby all day shift workers in the employment of the firm will receive an advance in wages. Time workers receive an increase of ½d. per hr. on their present rates, and piece workers an addition of 5 per cent. The increases will apply to the workers of the company at Burntisland, Kinlochleven, and Foyers.

The Antiquity of Copper and Its Alloys

In a Paper, read before the Birmingham Archæological Society recently, Dr. Maurice Cook discussed the early production of copper and copper alloys. Knowledge of the metallurgy of copper, he said, probably originated in south-west Asia and in Egypt as long ago as 4500 B.C. It spread westwards, and it was possible that the knowledge was introduced into China from western Asia. Stone Age communities were self-sufficient, but the use of metals in place of stone stimulated progress. The Romans worked copper mines in many parts of their empire, including Britain, but in this country the copper industry dated from the formation of the Mines Royal Company in 1568.

Dr. Cook said it had been suggested that bronze was first made in Khorassan, Persia, but the origin of the alloy was not known with certainty, although in Mesopotamia it was in use in 3000 B.C. Bronze was harder than copper, and replaced that metal for making weapons, tools, implements and utensils in many parts of the world. After it had been superseded by iron for many purposes, it was still employed for statuary, ornaments, works of art, gun-making and bell-founding.

Although brass remains had been found in Palestine dating back to 1400 or 1000 B.C., continued the speaker, the alloy was not generally known until about the beginning of the Christian era, when it was used for coinage by the Romans. For centuries brass was made by heating copper with charcoal and the zinc-ore calamine, for zinc was not produced in Europe until comparatively recent times. In England the first works for the manufacture of zinc was set up about 1740 and before the advent of Continental metallurgists, who were brought to this country in 1564 to establish brass manufacture, the alloy was generally imported.

Alloys of Tin with Germanium and Beryllium

The alloys formed by the addition to tin of low-melting metals, such as bismuth, antimony, lead, cadmium and zinc, have been studied fairly extensively, and now a systematic investigation of the alloys of tin with germanium and with beryllium has been carried out. The work was undertaken for the International Tin Research and Development Council by Professor W. Guertler and M. Pirani at the Institut für Angewandte Metallkunde in Berlin, and it is published as Technical Publication, Series A, No. 50, "The Systems Tin-Germanium and Tin-Beryllium." Technique for the preparation of tin-germanium alloys is described. The tin-rich end of the equilibrium diagram of the binary system has been investigated by microscopical examination and thermal analysis. The alloys consist of crystals of germanium in a ground-mass of tin containing 0.1-0.01 per cent. of germanium. Investigation of the mechanical properties shows that the addition of 0.35 per cent. of germanium to tin increases the Brinell hardness by 100 per cent., decreases the ductility by 20 per cent., and decreases the bending strength by 50 per cent. The preparation of tin-beryllium alloys is described. The alloys consist of primary beryllium crystals in a ground-mass, which is shown by spectrographic analysis to consist of tin containing a few tenths of a per cent. of beryllium. The addition of 0.2 per cent. of beryllium to tin increases the hardness very slightly, reduces the ductility by 20 per cent., and improves slightly the bending strength. The influence of small additions of antimony, bismuth, lead, electrolytic and refined zinc, and arsenic, respectively, on the hardness, ductility and bending strength of tin has been determined and compared with that of germanium and beryllium. Copies of the above publication may be obtained free of charge from the International Tin Research and Development Council, Manfield House, 378, Strand, London, W.C.2.

The Graphite Structure of Grey Cast Iron and Its Modification

By J. G. PEARCE, M.Sc., F.Inst.P., M.I.E.E.

(*Continued from page* 231.)

Explanation of the Results

It had already been demonstrated that the conversion of flake to supercooled graphite could be accomplished by melting a kish-free iron, incorporating 1 to 2 per cent. of ferro-carbon-titanium and then treating the molten metal with carbon dioxide for two minutes. The experiments detailed suggested that both flake graphite and supercooled graphite structures arise through the generation of inclusions in the melt. There was reason to believe that, in any ordinary supercooled graphite irons containing supercooled graphite is deposited, it is suggested that the inclusions are still liquid externally when the metal solidifies, so that these do not inoculate the melt, which subsequently supercools. Inclusion-free melts also supercool and Hanson[10] found that iron-carbon-silicon alloys made from pure materials, melted *in vacuo*, gave fine graphite structures, and these were coarsened by remelting in air.

It is suggested that in the case of titanium treatment, that the titanium is oxidised and forms a fluid slag of low melting point which coats the existing particles and prevents them inoculating the melt. Work is in progress on the separation of inclusions from the melt and from graphite and on their chemical analysis and physical properties. An iron graphitised by nickel shows supercooled graphite if the melt does not contain silicon. The same appears to apply to aluminium, and in both cases when silicon is present the graphite is coarse. In the case of copper in the presence of silicon, when there is sufficient free copper present to coat the inclusions, the graphite supercools, otherwise the graphite is coarse. Hydrogen coarsens by reducing ferrous oxide in the inclusion and raising its melting point. Additions of oxidised silicon, aluminium, or calcium silicide would produce particles of sufficiently high freezing points to yield coarse graphite.

Many possible alternatives have been tried to produce the refining effect, but the use of titanium followed by carbon dioxide appears to be most effective.[11]

The effect of superheating would be that of producing an inclusion-free melt due to flotation of the inclusions. Kiel and his collaborators[12] in a valuable series of investigations have suggested that coarse graphite structures are due to submicroscopic silicate slime. It is suggested, however, that a theory proposing to explain fine graphite structures must do so on a basis of the presence of inclusions. It cannot be assumed that supercooled graphite melts are inclusion-free. It is also suggested that a similar theory explains the modification of aluminium-silicon alloys.

FIG. 4A.—UNTREATED IRON SHOWING FLAKE GRAPHITE. UNETCHED. × 50.

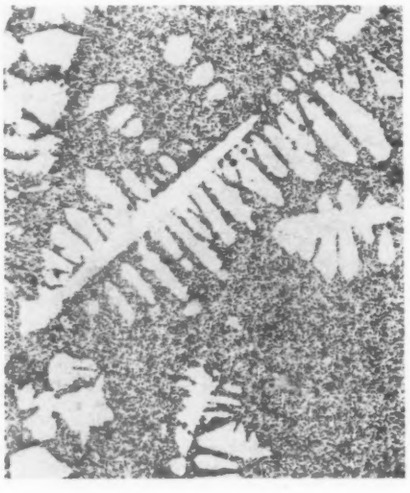

FIG. 4B.—TREATED IRON SHOWING SUPERCOOLED GRAPHITE. UNETCHED. × 50.

FIG. 4C.—SAME AS FIG. 4A.. ETCHED. × 200.

FIG. 4D.—SAME AS FIG. 4B. ETCHED. × 200.

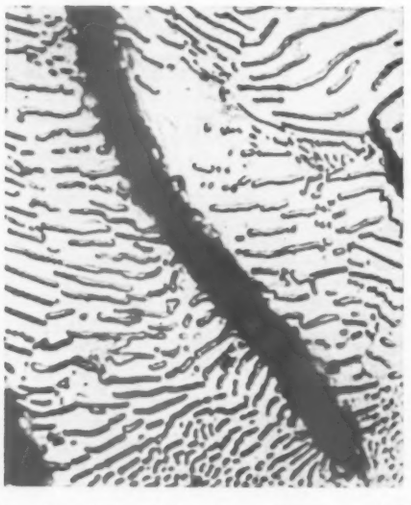

FIG. 4E.—SAME AS FIG. 4A. ETCHED. × 1,500.

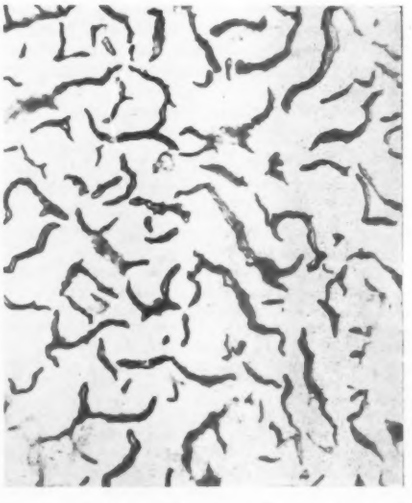

FIG. 4F.—SAME AS FIG. 4B. ETCHED. × 1,500.

Large Scale Melts

The above experiments suggested that fine graphite structures could be obtained in any grey iron by dissolving 1 or 2 per cent. of ferro-

carbon-titanium in the melt and subsequently treating it in the molten state with carbon dioxide. That successful refining had not previously been obtained with titanium was assumed to be due to the omission of the oxidising treatment. This, however, proved to be only partly correct, since the application of the refining treatments cupola metal in the ordinary way

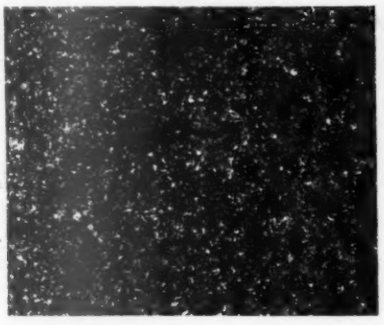

FIG. 5A.—FRACTURE OF UNTREATED BAR. × 1 1/16.

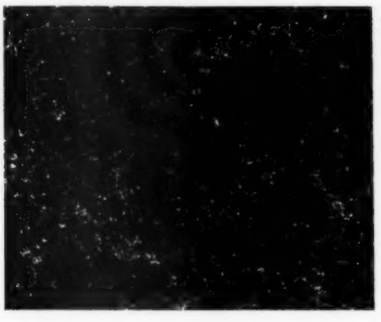

FIG. 5B.—FRACTURE OF TREATED BAR. × 1 1/16.

met at first with little success and further experiments were made.

A number of experiments were tried on crucible melts containing 23 kg. and 90 kg. of metal, the established procedure being to add 2 per cent. ferro-carbon-titanium and then to bubble carbon dioxide from a gas cylinder through the melt for two minutes, through a ½ in. dia. steel tube, protected by a plumbago sleeve where it entered the metal. The refinement was not complete and varied from one melt to another. It was observed that the ferro-carbon-titanium, melting point about 1,400 deg. C., was difficult to dissolve and often became coated with slag which prevented its solution. Ferro-silicon-titanium (20 per cent. Ti) was therefore obtained, having a melting point about 1,200 deg. C., and gave much better results. It was possible to obtain completely refined graphite structures through 3 in. dia. sand-cast bars, as illustrated in Figs. 5. The iron is a hematite pig-iron melted with 10 per cent. steel to render the melt slightly hypo-eutectic, and Figs. 4 show the structures in the untreated and treated condition at various magnifications, Figs. 5 show the fracture, untreated and treated, at A and B. Figs. 6 show the structure of grey iron containing silicon, A having copper below and B above the solubility limit.

Attempts to apply the same procedure to cupola metal were still uncertain in their results, and, where refining was unsuccessful, little or no increased titanium content was found in the metal. The question of getting the full titanium yield in the treated metal became important. As much cupola melting is carried out at comparatively low temperatures, an alloy addition was developed having a still lower melting point, of about 1,000 deg. C., obtained by dissolving 35 of 80 per cent. ferro-manganese and 15 to 20 per cent. ferro-phosphorus in the above mentioned ferro-titanium alloy. It was ultimately found that the best and most consistent yield of titanium in the molten metal was obtained by wrapping the titanium alloy in a thin steel sheet packet and plunging it below the surface of the metal with a heated plumbago plunger. This prevented oxidation or coating by slag.

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10 Hanson, Journal Iron and Steel Institute (1927), No. 2, page 129.
11 Brit. Pat. 425,227 (Prov. Spec. 25,028 of 1933); U.S.A. Pat. 739,670; German Pat. App. B. 166,441.
12 Keil and Legat, "Giesserei," May 26, 1933, page 214. Keil, Mitsche, Legat and Trenkler, Archiv für das Eisenhüttenwesen, Vol. 7, April, 1934, page 579. Mitsche, Carnegie Scholarship Memoirs (1934), Vol. 23, page 65.
13 Norbury and Morgan, "The Fracture of Pig-Iron and Cast Iron," Proceedings Institute of British Foundrymen, Advance copy, June, 1936; FOUNDRY TRADE JOURNAL, June 11, 1936.
14 Gough and Pollard, Proceedings Institution of Mechanical Engineers, Advance copy, November, 1935.

Cupola Melting

Some titanium-bearing pig-irons were found to give a refined structure on a 3-in. bar by simply remelting in the crucible with 10 per cent. steel. From the cupola, however, the same mixture was usually much coarser even after carbon dioxide treatment, and the strengths were correspondingly lower than those from crucible-cast bars. The cupola-cast metal also gave only slightly less coarse flakes on remelting in the crucible and treating with carbon dioxide, although full treatment with a titanium addition following the gas refined them completely. Chemical analysis did not account for these differences and additions of over 0.1 per cent. sulphur to the crucible melts did not make any difference. Charges melted in the crucible with coke coarsened the structure even when steps were taken to offset the effect of carbon pick-up. Also the addition of sodium carbonate to the coke appeared to reduce the coarsening action. It was found, moreover, that the same charges were coarsened by melting in oil-fired and pulverised-fuel fired rotary furnaces, so that coke ash was probably not the main cause of coarsening cupola metal. The oxidation of crucible melts by carbon dioxide, air, etc., while resulting in appreciable losses of silicon, manganese and titanium, did not coarsen the graphite. Treatment, however, with hydrogen showed that metal subject to both

(*Concluded on page 256.*)

TABLE I.—*Irons A and B of Similar Analyses and Different Mechanical Properties on 3-in. dia. Sand-cast Bars. A, Normal Flake Graphite. B, Supercooled Graphite.*

Analysis. Per cent.	A.	B.
Total carbon	3.59	3.47
Combined carbon	0.73	0.28
Silicon	2.78	2.87
Manganese	0.72	0.59
Sulphur	0.03	0.03
Phosphorus	0.02	0.02
Titanium	0.07	0.28
Transverse rupture stress (tons per sq. in.) on 18-in. centres	17.4	30.3
Tensile strength (tons per sq. in.):—		
0.375-in. bar from near centre of bar	8.5	12.3
0.375-in. bar from half-way centre to edge	7.5	19.5
Brinell hardness (10/3,000/30):		
Centre	152	174
Edge	134	179
	143	170
	163	174

FIG. 6A.—GREY IRON CONTAINING COPPER BELOW LIMIT OF SOLUBILITY. GRAPHITE REFINED BUT FLAKEY. UNETCHED. × 200.

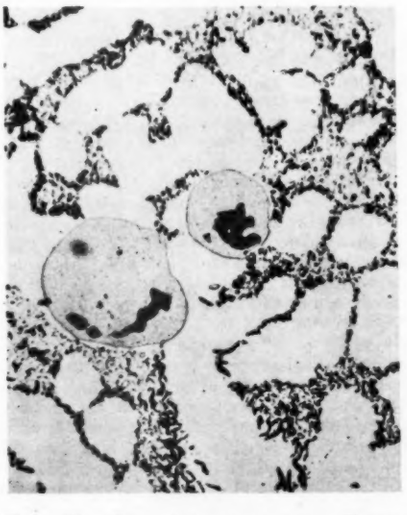

FIG. 6B.—GREY IRON CONTAINING COPPER ABOVE THE LIMIT OF SOLUBILITY. GRAPHITE SUPERCOOLED. FREE COPPER VISIBLE. UNETCHED. × 200.

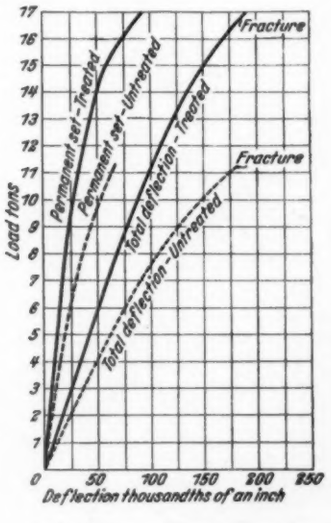

FIG. 7.—TOTAL DEFLECTION AND SET CURVES ON A 3-IN. BAR TAKEN AT 18-IN. CENTRES.

The International Foundry Congress at Dusseldorf

ABSTRACTS OF PAPERS

We have already published abstracts of some Papers which were presented to the International Foundry Congress held in Düsseldorf last year. Copies of the remainder of the Papers have now become available, and we append abstracts of these. If readers will indicate which Papers they would like reproduced in full, we shall be pleased to do so if the demand is reasonably insistent.

The Standardisation of Testing Moulding Sands

By FR. BOUSSARD.

The first tests on sand comprised only chemical analysis and grain size determinations, but it was quite impossible by this means to characterise sands which would behave well in service. Afterwards attempts were made to study the service characteristics, such as bonding strength and permeability. The determination of these two properties has permitted the solution of numerous sand problems. The two stages of development of the sand testing methods are described, and it is pointed out, that at present the elementary properties are again being utilised for interpreting the variations of the service properties.

The grain size analysis of sands, which is of prime importance in the selection of new sand and also in the establishment of mixtures, may be carried out by the following general methods: (1) Screening; (2) elutriation; (3) sedimentation (A.F.A. method).

From an examination of the different methods it may safely be concluded that separation of the clay and the sand grains is not possible without subjecting the sand to a preparatory treatment. Therefore, the following points are dealt with separately:—(*a*) Preparation of the sand; (*b*) separation of grains and clay substance.

The Preparation of the Sand.—The following procedures may be adopted. The stirring method with a mechanical stirrer of the A.F.A., 60 r.p.m. 50 gr. of sand, 475 m.l. of water and 25 m.l. of sodium hydroxide solution (concentration 10 gr. per litre).

In testing a sand, one obtains:—Without stirring, 14.4; stirring 20 min., 17.8; stirring 1 hr., 21.4; and stirring 2 hrs., 22.0 per cent. of clay substance.

The boiling method, using the sand material and same quantities as above, gives the following results:—Without boiling, 14.4; boiling 8 min., 19.0; boiling 15 min., 22.0; boiling 30 min., 23.4; and boiling 60 min., 23.4 per cent. of clay substance.

The addition of an electrolyte to 50 gr. of sand, dispersed in 475 m.l. of water and stirred during 1 hr. in the A.F.A. stirrer, gives the following results:—Without electrolyte, 18.4; 25 m.l. sodium hydroxide added, 21.4; and 50 m.l. sodium hydroxide added, 21.2 per cent. of clay substance.

Separation of the Clay Substance.—The classification of the grains according to size by wet methods, as recommended by Crook and Boswell, requires numerous manipulations and a rather long testing period. It is sufficient simply to remove the clay substances by the wet method and to continue the classification of the grains by dry screening.

The American method is based on this principle, and it is adapted for extremely careful determinations, since it eliminates the experimental errors due to the personal factor. For routine testing, however, the sedimentation method as proposed by the A.F.A. requires too much time and it necessitates the continuous attention of the experimentator for 1.5 to 2 hrs. (only for syphoning off). The author, therefore, suggests a procedure intermediate between the American and the English method, *i.e.*, the principle of the A.F.A. is retained, but the syphoning operations are substituted by separation with a current of water, as effected in the elutriators by Crook and Boswell. The separation is made in a rather large funnel of 300 mm. of dia.; by adjusting the velocity of the water current at 25 mm. per min. in the upper portion, the velocity will be much higher in the lower portion, the sand thus being conveniently agitated. The sand may thus be freed from its clay substance by an intensive washing lasting 1 hr., during which time no special attendance is required.

The Importance of X-ray Examination of Macrostructures and Crystal Structure for the Foundryman

By E. SCHIEBOLD.

After brief references to the general importance of the X-rays for testing materials and their specific importance to the foundryman, the generation and characteristics of the X-rays are reviewed with the view to establishing the conditions for an intimate co-operation between foundryman and radiologist and for the application of this testing method in practice. After reviewing the principles underlying the construction of X-ray apparatus for testing and investigating materials, in the first part of the Paper some modern X-ray units for voltages above 200 k.v. are described, and it is shown how they may be used technically by means of the X-ray motor van for instructional and testing purposes. In the second part of the Paper the principles of the technical radioscopy (weakening of the X-rays in penetrating the material, radioscopic screen examinations, judging the quality of the radiograph, standardisation) are reviewed as far as it is necessary for the understanding of the radiographs. In the third part the applicability of the radioscopy to the testing of castings during the various stages of production is discussed. The X-ray method being a non-destructive testing method, a far greater field of application is secured than with other testing methods, so that the soundness of practically every single completed casting may be checked. A review is given on casting defects principally detectable by means of X-ray examination; their causes and their interpretation in the radiograph are widely discussed by means of a great number of original X-ray pictures obtained by the author in examinations and in collaboration with foundries of high capacity.

Special consideration is given to the development work of H. Reininger, who first tried to apply the X-ray examination in the moulding and core shops as well as in the assembly of the moulds and cores. The use of the X-ray technique in the production of a casting facilitates first the selection of the appropriate materials and—in addition to the conventional testing methods—the examination of their tendency to shrinkage and gas absorption; furthermore, the early detection of casting defects without destruction of the part, whilst from the appearance and interpretation of the X-ray photograph an appropriate change of the casting conditions may be proposed. These advantages of X-ray examination are discussed and illustrations of steel castings and light metal die-castings are shown.

The radioscopic methods find another important field of application in the treatment of castings (annealing, hardening, quenching, applying metallic coatings) and here the examination of microstructures has recently gained special importance. A varied field of application for the X-ray technique, where it has already found an extended use, is the inspection of welds in castings, as well as the control of hot- and cold-working processes on cast ingots, plates, etc., as, for instance, of pressing, rolling, drawing of bars, wires and tubes, and riveting.

In the fourth section of the Paper the application in the foundry of the ultra-short wave X-rays and of the gamma rays is discussed by means of examples. The fifth section is devoted to a comparison between the X-ray methods and other testing methods, and it is shown that the X-ray method exceeds the limits of a technological testing method, in so far as it does not require the destruction of the part under examination for discovering its structure. Especially emphasised is the combination of technological and X-ray testing and comparison of results, in order to establish the conditions for accurately checking by means of radiographs the quality of a product as to its future behaviour under service stresses.

Finally, a short review is given on the principles of crystal examination by means of X-rays and electron interferences, and the application thereof on problems of metallurgy and foundry technique is shortly dealt with.

Testing of Oil Cores*

By H. NIPPER.

In the introduction and in various parts of the Paper a short review is given of the literature available on oil cores. The requirements which oil cores have to meet are discussed and six different ranges of stresses are distinguished, particulars being given as to properties and behaviour of: 1, The ready-for-use oil-sand mixture during moulding; 2, the core in green or rough, undried and unbaked condition; 3, the core during drying and baking; 4, the core in dried and baked condition; 5, the core whilst heated by the molten metal and the gradual changes undergone during solidification and further cooling of the casting, and 6, the core or core material during cleaning.

The factors influencing the properties and the performance of an oil-sand mixture and oil core respectively are the sand with its special additions, if any, the oil with its additions, if any, the treatment during manufacture and the kind of stressing.

Core sands may differ as to grain size, grain shape, surface condition of grain, mineralogical composition of the single grains, clay content, its mineralogical composition, quantity and distribution, and moisture content. The influence of the different variables is discussed in detail. Particulars are given on the influence of the second component, the oil binder, which has a decisive bearing on the structure of an oil sand and the core. Suggestions are made on a laboratory test of a more chemical nature, its usefulness and applicability being examined. In addition, a new practical method of testing the bonding power of core oil is described.

Closely fitting metal or quartz rings were slightly wetted with oil and baked in a furnace under conditions of constant temperature and air circulation for a certain period. Then the rings provided with grooves were clamped into a special device, where the oil films were broken. The total length of the cutting edge amounted to 100 mm., the width of the oil film was extremely small, only 0.5 to 1.0 mm., the area of adhesion being therefore of the order of 0.5 to 1.0 sq. cm. Depending upon the kind of oil, time and temperature of drying, a bonding strength of 20 kgs. and more was obtained. Rings of pure quartz yielded higher values than

* Communication from the Foundry Institute of the Technical High-School at Aachen.

smooth brass or aluminium rings, whereas the strength obtained in case of metal rings with etched or roughened surfaces were equal to that obtained with quartz rings. The test was highly sensitive and especially suited for determining the optimum drying conditions of different oils.

On several transparent polished sections the importance of the core structure, particularly the influence of the ratio in the mixture of quartzite + oil + clay and the distribution of these constituents are demonstrated. Furthermore, compression and shear tests, as well as tests on the permeability of gas on baked oil cores are discussed. Particular mention is made of a new method of testing abrasion, as developed in the Foundry Institute of the Technical High-School at Aachen. The device consists of a casing provided with a hopper for the collection of the sand abraded; within the casing a brush of 190 mm. in dia. rotates round a horizontal axis with an adjustable number of revolutions (usually 300 r.p.m.). The brush is faced with steel wire scratchers, as employed in the cloth industry. The test was carried out by pressing the core, which was horizontally pivoted in the case, eccentrically towards the brush with a pressure which could be adjusted as required. Simultaneously the core too could be rotated with an adjustable velocity. The quantity of sand rubbed off during a determined period or with a certain number of revolutions made by the brush (100 to 300, average) was collected and weighed. The results are given of an abrasion test on several cores which were prepared with different oils and baked at three different temperatures. Cores prepared with linseed-oil exhibited only a slight abrasion at all temperatures. The oil having quite a good bonding power is very sensitive both at high and low temperatures and highly influenced by the baking period. The third oil has inferior properties. The abrasion is substantially greater with all baking temperatures.

The type of stresses laid upon the cores at high temperatures and the resulting gas evolution during baking of the core and pouring are broadly discussed. The works of Swagerman, Klingenstein and Dietert are reviewed, and, in comparing their results with those obtained by the author, a good agreement has been found. Baking and coking tests with oil core samples were carried out in a closed receptacle.

In order to obtain some idea of the quantity of gas liberated during the pouring of iron in a mould prepared from oil sand, a practical pouring test was undertaken. In a special device cylindrical specimens of 30, 40, 50, 65 and 80 mm. dia. and with a height of 50 mm. were cast through a gate of 20 mm. dia. and 30 mm. high. A perforated basket, which is lined with the baked oil core mould was suspended in a steel box, the lid of which could easily be sealed. The top of the basket consisted of a closely sealing iron plate, leaving space only for the gate. The whole receptacle was provided with a manometer, connected to a gas holder. Immediately after pouring the upper (second) sealing cover was closed and the gas liberated was collected in the gas holder. The quantities of gas evolved are shown graphically.

Micro-analytic Research Methods for Foundry Products

By M. Niessner.

In the introduction the author describes the tasks of micro-chemistry involving the presentation of scientifically founded methods, which permit the execution of chemical processes with minute quantities of a substance. The problems arising in the foundry which are expected to be solved by means of micro-chemical methods are of an analytical nature only; therefore, all further comments refer to micro-analysis. Whilst the classical micro-analysis made use of the separation of crystals in very small samples, it has been possible by systematic researches in the field of accurate and highly sensitive reactions to develop an analytical method by means of drop reactions, which has proved to be of particular importance for the examination of metals. The author shows the possibilities of this method of analysis for the identification of elements present only in traces in the presence of large amounts of other substances. By appropriately transferring these highly sensitive reactions on gelatine or filter paper, it is not only possible to determine the chemical nature, but also the distribution of the element to be analysed. These print methods are especially advantageous for the identification of heterogeneity, segregations, non-metallic inclusion, undissolved particles of metallic alloying constituents, and so on. For the purpose of showing the results of these methods, the author presents the following examples:—The accurate detection of sulphur and phosphorus segregations; the identifications of oxide inclusions or of undissolved copper in iron. As examples for the application of the quantitative micro-analysis the quantitative analysis of slags, the determination of dissolved alloying constituents not uniformly distributed and, finally, the possibility of applying micro-chemical methods in corrosion work are discussed.

Influence of Compression on the Properties of Moulding Materials

By Prof. Dr. Pisek and Ing. Holman.

On the basis of numerous tests the authors have established the influence of compression on the permeability and binding strength of moulding sands. In order to express this influence in figures, new terms have been developed and established, such as "sensitiveness of permeability" and "sensitiveness of bonding strength."

Since it is difficult to determine these sensitivenesses in the laboratory, it has been undertaken to establish certain relations between these sensitivenesses and other properties of the moulding sands, which may be determined more readily, as, for instance, the compression strength and the bonding strength. Thus, curves have been plotted, by means of which it has been made possible to draw conclusions from results obtained with the conventional testing equipment on the values for the sensitiveness, as defined above, in such a manner that an indication as to the infallibility of obtaining satisfactory agreement is given. The usefulness of the new term "sensitiveness of permeability" in practice is illustrated by an example.

The Cast Alloys Elektron and Hydronalium

By P. Spitaler.

The tensile properties of the most important Elektron cast alloys (magnesium, containing 3 to 10 per cent. of aluminium and small amounts of zinc, manganese and silicon) are tabulated. The "life" of the magnesium alloys is exemplified by two patented processes:—(1) The treatment of the molten metal with the cleansing salt Elrasal; and (2) the addition of sulphur and boric acid to the moulding sand. As regards the Elektron alloys containing aluminium, their structure may be refined by superheating them well above their melting point (900 deg. C. approximately), this treatment improving both the ultimate strength and the "life." In the casting itself the shrinkage is smaller owing to the resistance of the mould and the cores. The shrinkage and contraction of the Elektron alloys is about of the same order as that of the most aluminium-base cast alloys.

The different formation of a shrinkage cavity for an alloy having a uniform melting point (*e.g.*, with the eutectic Mg-Si alloy CMSi) and an alloy with a larger solidification interval (*e.g.* AZF) is illustrated by means of a simple casting. In the case of pure metals and eutectic alloys, a solid skin is rapidly formed at the walls of the mould, so that an internal cavity is likely to occur with insufficient feeding of molten metal, whilst with alloys with a greater solification interval, the outer skin solidifies first, and is of a spongy texture. As a result, the outer skin will sink in owing to its own weight or owing to the gas pressure existing at the surface of the mould, and a cavity is formed. The means for preventing cavity formation are generally the same with both alloy types, *i.e.*, a suitable arrangement of the gates and risers and the application of chills. For obviating pressure cavities a sufficient permeability of the corresponding parts of the mould (the moulding sand must not be too wet, moulds and cores must not be rammed too firmly) has to be aimed at.

The influence which the manner of pouring the mould exerts on the prevention of intergranular cavities is illustrated. The most favourable results have been gained by a pouring method, whereby the molten metal flows as little as possible through the mould proper, but is introduced to every point of the casting from the nearest gate. Thus, the fundamental requirement that every point of the casting be in contact with molten metal during its solidification will be fulfilled.

The detrimental effect of very sharp and abrupt corners and edges is shown, and it is stated that sometimes a mass of material is preferable to a deeply recessed angle. Sudden changes of section, however, have definitely to be avoided.

The Hydronalium cast alloys belong to the aluminium-base alloys, and they have, therefore, a specific weight of 2.6 approximately. These alloys are characterised by a very good corrosion-resistance, particularly against sea water, soap and soda solutions, as well as against other alkaline reagents, besides having favourable mechanical properties. That it lends itself well to polishing, must be considered as an additional valuable quality.

The mechanical properties of cast Hydronalium alloys are tabulated. On account of the high magnesium content of the Hydronalium, it has been necessary to adopt similar methods in melting and pouring to those adopted when casting Elektron. For preventing undesired reactions protecting agents, particularly boric acid, are added to the moulding sand.

Hydronalium finds its use especially in parts for shipbuilding, the chemical industries, and for fittings of every kind.

Corrosion-Resisting Cast Aluminium Alloys

By Dr. Sterner-Rainer.

The practical experiences of many years have been necessary to select a few reliable alloys from the numerous materials developed, for which their inventors have incorrectly claimed corrosion resistance. Alloys with iron contents above the usual percentage in commercial aluminium or with a copper content of 0.05 per cent. and more, as well as complex alloys (as, for instance, remelted material) should be eliminated for all parts which will be subjected to corrosive influences. Valuable as may be the addition of $MgZn_2$ to aluminium as regards its age-hardening effect and its influence on the sensitiveness to polishing and anodic treatment, it must, however, be pointed out that with increasing additions the corrosion resistance will be reduced.

Among all alloying elements of pure aluminium, magnesium has to be considered the most important element for maintaining and increasing the corrosion resistance. Introduced into industrial use by Ludwig Mach at the end of last century, the Mg-Al alloys have been condemned both in practice and literature, in some quarters even until recently. The value of the magnesium addition to aluminium has not been appreciated until the author had made his ex-

periments in the Baltic sea with a series of aluminium alloys; owing to the surprisingly good results of this research work the prejudice against these alloys has disappeared. On the basis of the experiences gained, a further improvement both of the corrosion resistance and the tensile properties of the alloys mentioned has been possible. Besides the discovery that the corrosion resistance of the Mg-Al alloys could be improved by additions of manganese, titanium and antimony, these experiments demonstrated that a substantial increase of the magnesium content may be tolerated under conditions where the Al_3Mg_2 crystal, which is always occurring during the solidification of such Mg-Al alloys, can be eliminated by a diffusion process. By this treatment the tensile strength, the elongation and the fatigue strength, as well as the resistance of high magnesium aluminium alloys against most of the corrosive agents are substantially increased, as illustrated by the Mylius corrosion test on homogeneous and heterogeneous magnalium in oxidising sodium chloride solution.

Thus the "Seewasser" (sea-water) alloys were developed, which owe their name to their especially good resistance against the attack of sea water. On the basis of these results the G Al-Mg and G Al-Mn alloys were created, which all are well known from the German Standard Specification DIN 1713.

The advances made in the production of pure magnesium and aluminium and in the alloying technique, and the progress in the field of surface treatment have contributed to bring the magnesium-aluminium alloys into prominence recently.

Additions of silicon within a certain range, while not notably decreasing the corrosive resistance, reduce the tendency to micropiping. The disadvantage of low silicon additions in reducing the elongation, in coarsening the fracture, may be overcome where silicon and magnesium additions are limited, if the greater portion of the Mg_2Si formed is kept in solid solution by solution annealing and rapid quenching. Such age-hardenable aluminium alloys containing small percentages of Mg_2Si have not only secured their application as wrought material but also as castings. The series of alloys which may be considered corrosion resistant may be completed by mentioning the Silumin and its modifications Silumin-Beta and Silumin-Gamma.

The corrosion resistant aluminium alloys are summarised in the groups 4, 7, 8 and 9 of the German Standard Specification 1713, whereas such a standardisation has not yet been made in other countries. At the end of the Paper a short review is given on the alloys used in other countries, for which corrosion resistance is claimed. In tests conducted by the author with some of these alloys the statements made regarding their corrosion resistance could not be wholly confirmed.

Experiences with High-Frequency Electric Furnaces

BY N. BROGLIO.

The author first gives a survey on the different types of electric furnaces, being used in foundries, and classifies them into four groups corresponding to their technical features:—(1) Arc furnaces; (2) resistance furnaces; (3) combined arc and resistance furnaces; and (4) induction furnaces. By means of practical examples the specific manner of operating furnaces belonging to the respective groups is described.

The induction furnaces, together with the coreless or high-frequency crucible furnaces, are described in a somewhat more detailed manner. After a short discussion of the principles underlying the operation of these furnaces, the single furnace parts, such as the nature of the condenser battery, the stages of development of the furnace control, and the switchboard equipment, are described. A whole section is devoted to the adjustment of the reactions.

After a discussion of the mechanical equipment, the mode of operation and consumption of a high-frequency furnace plant is reviewed. The consumption of lining materials and the cost of electric power are also discussed. The metallurgy of the high-frequency furnace is reviewed, due consideration being given to foundry practice. The author points out the limits of the economical use of the electric melting process in foundries. He emphatically states that the high-frequency process has not superseded other melting methods hitherto used. The author is of the opinion that every production unit has its specific economic merits in a well-defined range of operations. The high-frequency furnace is a new production unit of the foundry, which will undoubtedly monopolise the fields of application, where it may be used safely and economically.

In a special section the requirements of power and time as a basis for calculating the economy of the process are discussed. From both requirements the author derives his opinion regarding the necessary dimensions, and he outlines the trend of future development both in Germany and other countries. In a detailed manner the author gives special attention to the advances made in Germany in the high-frequency practice, since the operation of the first furnaces in continuous service in the year 1929. Before this date the Kaiser-Wilhelm-Institut für Eisenforschung had carried out preliminary experiments for several years.

The main fields of application of the high-frequency furnace, namely, the melting of high-grade steels for rolling and forging purposes and the production of special steel castings, had an appreciable bearing on the advancements made in the design of the furnaces.

The tendency to keep the power consumption as low as possible gave way to the conception that the improved quality of the product and the higher operating safety of the furnace are far more important than a consumption of 100 kw. more or less. On the basis of this conception, the problem of power input was attacked, which now may be considered as solved in a satisfactory way (500 to 2,000 Hz., 1,500 to 3,000 volt). Above all, a connection system has been introduced recently, which permits of a simultaneous operation of two furnaces from one unit, thus giving the possibility of a continuous full-load utilisation of the motor-generator set in a most economic way.

The experiences gained with coils have led to the use of a one-wire wound, water-cooled coil, whilst in the design of the frame some differences are encountered, which, however, have no essential influence on the production.

In Germany an acid lining is generally adopted for the crucible, the use of a basic lining being still in an experimental stage. The high-frequency furnace already occupies an important place, and is constantly gaining in favour on account of its ideal melting characteristics for the production of commercial grades of steel. The main object of this Paper is to give the foundryman some suggestions as to the possibility of using the new process for special purposes in the foundry, just as it has been introduced as a valuable unit in the steelworks.

Casting High-Quality Steels

BY DR.-ING. F. PÖLZGUTER.

Since the introduction of cast steel, noticeable advances in the production of steel have been made, particularly with the introduction of the electric steel melting furnace. The plain cast steel initially used was soon partly substituted by the low-alloy cast steel with its superior technological properties. In recent times, highly alloyed cast steel has also been produced.

Whilst the phenomena encountered in the solidification and heat-treatment of plain cast steel may be explained and interpreted by means of the diagram for the Fe-C system, the conditions are considerably more complicated in the case of the complex highly alloyed steels. For some chromium and chromium-nickel steels of particular importance, the behaviour on solidification and heat-treatment is explained by means of simplified quasi-binary diagrams. It is possible to divide highly alloyed steels into pearlitic steels solidifying with a distinct transformation of structure, and into ferritic or austenitic cast alloys exhibiting no transformation at all, the grain-structure of which cannot, therefore, be influenced by a subsequent heat-treatment. Finally, carbon-free alloy steels have been used recently, which usually solidify without any transformation, the physical or technological properties of which may be improved by precipitation hardening.

For the production of highly alloyed cast steel the electric furnace is especially adapted. Of particular value is the high-frequency furnace, which permits the production of all kinds of highly alloyed steels in a crucible-like melting vessel. The high-frequency furnace lends itself also to the melting of the new carbon-free steels, which frequently contain readily oxidising constituents, as for instance more than 12 per cent. of aluminium in the newly developed permanent magnet steel.

Highly alloyed cast steel, heated to sufficiently high temperature, is usually more fluid than plain carbon cast steel, and may be cast into extremely thin-walled pieces of high precision. Either dry-sand, green-sand moulds are used, or in special cases die-casting may be applied. The respective fields of application for each of these casting methods are described. The greatest proportion of highly alloyed steel castings are produced by green-sand moulding. Details are given about the preparation of sand and core-making. Since shrinkage is relatively high, special precautions in casting are required in order to prevent cracking.

The arrangement of gates and feeders is shown by means of practical examples, but owing to the diversified nature of the subject, general outlines can hardly be given. With the aid of several figures, correct and incorrect designs for castings are explained. Stress is laid on the necessity of avoiding sharp discontinuities of section, of obtaining a uniform wall-thickness and making use of sufficiently large fillets. In the case of castings made from austenitic steels, besides a due consideration of the casting technique, the high expansion value of the material must be allowed for. The operations of cleaning, knocking-off the risers and the manufacture of patterns are shortly discussed.

According to their applications, highly alloyed castings are divided into three groups:—(1) Castings for tools; (2) structural parts; and (3) castings having to meet special physical requirements. By means of illustrations, a survey is given on tools as used in practice, on structural parts, on corrosion- and heat-resisting steel castings and on cast magnets. The particular technological and physical properties of the steel grades used are also described.

Foundry Technique as an Introduction to the Education of Designing Engineers

PROF. DR. A. KESSNER.

Everywhere in technical high schools and other technical colleges one of the most outstanding problems is the education of the designing engineer. The entire study at the faculties of engineering is concentrated on this training, since the duties of the engineer as a designer represent the most essential part of his creative work. As the guiding principle in the education of the designing engineer it is now generally accepted that mechanics, knowledge of materials and mechanical technology are the fundamentals of the proper science of construction.

The forces acting in a machine part and the distribution of stresses being determined, a material has to be selected which is the most

suitable for safely absorbing the acting forces set up. The designing engineer, therefore, must have a thorough knowledge of the physical, chemical and mechanical characteristics of the materials and develop the most economic design in due consideration of the inherent properties of the material. The problems of design and material can only be solved together, and it is a preliminary condition, therefore, that the student, before beginning his studies, has obtained a certain manual skill in the most important operations, such as forging, pressing, moulding, casting, and welding. An especially good training method for the future designing engineer is some practical work in the pattern-making shop and in the foundry. Here the student learns for the first time how to transfer the forms laid down in the drawing into the three-dimensional space, *i.e.*, into reality.

The foundry technique offers a variety of instructive examples for the training of the designing engineer. The ever-changing mode of thinking from the work-piece to the mould, from the cavity to the core, develop to a high extent the correct conception of space. The designer must thoroughly know how a pattern is made, how it is moulded and where to joint it. If the designer would indicate on the drawing where to joint the mould, many rejections and losses could be eliminated.

In designing the engineer must have in mind whether the casting shall be moulded to pattern or to sand or loam template. A pattern is said to be "fit for moulding" if the casting may be produced with the least amount of material and wages. As regards the pattern, special attention must be given to the taper, to permit an easy removal of the pattern from the sand. All projecting parts, such as surfaces to be machined, bosses and ribs, should be attached to the pattern and arranged in relation to the position of jointing. With solid castings cores are to be avoided, since their manufacture requires an additional expense for sand, core irons, waxed thread, as well as wages. Nowadays it is more economical to bore screw holes than to mould them. In manufacturing hollow castings the designer must understand how cores are made, inserted into the mould and vented. The cleaning of the casting is rather difficult, unless sufficiently large openings for removing the sand and the core irons are provided for.

Of particular importance is the problem of equalising wall-thicknesses. All sections of the casting need not have equal wall-thicknesses, but all portions of the casting must solidify simultaneously. If this condition is obtained, casting stresses are not likely to set up. The rejections in the foundry are mostly due to shrinkage and piping. Pipes being inevitable, care should at least be taken to locate them into parts, where no harm can be done, *i.e.*, into risers.

The education in designing must, therefore, go hand in hand with technologic education, and the collaboration between designer, foundryman and practical engineer must be initiated at the university.

By means of selected examples the author indicates in which manner at the technical high school at Karlsruhe the foundry technique is taught as an important preliminary step in the training of the designing engineer.

The Impact Strength and Notch Sensitiveness of Cast Iron

By E. Piwowarsky.

The impact strength of cast iron is influenced by the shape of the specimen and the distance between supports. Specimens with a sectional area of up to 1 sq. cm. are less suitable for determining the impact strength of cast material. Of paramount influence on the impact value is the striking velocity. Strictly comparable values are, therefore, only obtained, if the shape of the specimen, the distance between supports (span) and the striking velocity are known. The casting skin has no substantial bearing on the impact value, especially in the unannealed condition. The best means for obtaining a cast iron exhibiting a high impact strength are a low carbon content and an appropriate thermal treatment. The notch sensitiveness of cast iron increases with the quality of the material. In the case of low carbon contents it is possible to obtain a remarkably high impact strength with cast iron of a higher phosphorus content. An international standardisation of the impact test for grey cast iron would be advisable.

Corrosion-Resisting High-Silicon Iron Alloys

By Dr. Raoul Dupuis.

The iron-silicon alloys with high corrosion resistance both against acid and basic reagents have been known and used for many years in considerable quantities for the construction of equipment for the chemical process industries, superseding ceramic materials, glass and ordinary cast iron used heretofore.

These alloys have silicon contents varying between 12 and 18 per cent. and apart from iron usually contain as main constituents: from 0.35 to 0.8 per cent. carbon, up to 0.8 per cent. phosphorus and from 0.5 to about 2 per cent. manganese. They are of a typical metallic colour, varying from white to a more or less light grey; the density varies between 6.8 and 7.1 and the melting point between 1,200 and 1,300 deg. C.

The alloys are very hard and brittle and are difficult to be machined, even with special tools, so that the castings are usually finished with the emery grinding wheel. The alloys appear in the trade under different brands according to the works manufacturing them, *e.g.*, Duriron, Thermisilid, Tantiron, Fomiac Si, Ironac, Elianite, Acidur, Corrosiron, Antiacid, Duracid, Neutraleisen, Métillure, etc.

Unfortunately the use of these relatively cheap alloys is restricted, not on account of their corrosion resistance, which in certain cases is good, but owing to their brittleness and the low mechanical resistance of the castings, as well as to the insufficient resistance towards sudden variations of temperature; besides which the design of the castings must not be too complicated.

Nevertheless, and in spite of the serious competition of the alloy steels, these cast alloys are still much appreciated in the chemical industry, for they have contributed to the marvellous advances made, particularly in the production of organic and inorganic acids, in dye manufacturing plants and in the production of explosive matter.

In the past a great many foundries produced castings from these alloys; most of them, however, have discontinued the production, owing to the considerable difficulties encountered and the relatively high percentage of rejections. Only a few firms have succeeded after long investigations and expensive experiments in overcoming these difficulties; in some cases their processes of manufacture have been patented, in other cases they have been kept strictly secret.

The difficulties may be divided into two groups: (1) Those arising in the production of the metals and (2) those which are met with during the moulding and pouring of the castings. According to the abundant technical and scientific literature on iron-silicon alloys, the following furnaces may be used for the melting of the alloys: the reverberatory furnace, the oil-fired rotating furnace, the crucible furnace, the electric arc furnace and the most modern unit, the high-frequency induction furnace.

Since such alloys in a molten condition will easily absorb gases during their preparation, it will frequently be necessary to prepare a preliminary alloy of an analysis similar to that desired in the final casting and to cast it into pigs. During solidification the gases will escape and after remelting the pigs the resulting castings are free from blow-holes and graphite nests. In order to avoid the more expensive process of manufacturing a preliminary alloy and remelting it, a direct method of producing the alloys has been developed.

In this process, molten and very hot mild steel is poured on metallic silicon; when the reaction between the two materials has ceased, the pieces are cast immediately afterwards, and excellent results are obtained. For the commercial manufacture of these alloys iron and steel scrap and iron-silicon alloys with different alloy content as well as pure metallic silicon (98/99 per cent. Si) may be used. The pouring temperature must be high enough to have a metal of sufficient fluidity which will readily fill the moulds, and in order to obtain perfect castings free from any defects.

Overheating is very dangerous owing to the tendency of the metal to absorb large quantities of gas. It is also recommended that the metal be cast at a low temperature, in order to avoid piping and cracking in the finished castings. Depending upon the carbon content, an alloy with or without free graphite—uniformly distributed in the matrix—may be obtained, *i.e.*, alloys having a more or less grey fracture. The grey type is not so brittle and is more easily machinable than the white one, since when machined powder and not chips are produced.

As regards the corrosion resistance the two types are of a somewhat different behaviour. The white type shows a considerably higher resistance towards the attack of corrosive agents. It is an interesting fact that the specimens when immersed in a corrosive medium will show a higher loss of weight with the first immersion than at the succeeding ones. The phenomenon may be explained by the fact that a very thin surface film of silica is produced protecting the metal underneath from further attack.

As regards the moulding of the castings, it must be mentioned that few of the complicated castings usually made from steel or ordinary cast iron can be made from an acid-resisting silicon alloy without substantially modifying the pattern. On account of the large shrinkage varying between 1.8 and 2.5 per cent., depending upon the composition of the alloy and the special physical properties of the metal both in the hot and cold condition, every effort must be made to eliminate sudden changes of section; the edges and corners should be rounded off and the pieces provided with ribs and convenient recesses, so that neither during casting nor in service failures will occur. Unfortunately not all the usual machine parts may be cast from these alloys for the reasons stated above.

Products made from these alloys are: parts of absorption towers, tanks, parts of pumps, pipes, cocks, valves, etc. The castings are preferably moulded in green sand, care being taken that the moulds are not rammed too hard and that the cores will permit easy contraction of the metal during solidification and cooling. Chaplets are to be avoided as far as possible, which, of course, cannot be made of another material than the casting itself. When pouring the metal into the moulds special care must be taken not to destroy the oxide skin formed during the casting process.

After pouring, the casting should be placed into a furnace to be gradually cooled down there. After cooling, gates and risers are removed, and then the castings must be accurately sand-blasted and, if necessary, pickled in hot dilute sulphuric acid.

The author himself has been producing such alloys, using the high-frequency induction furnace and starting with iron-silicon alloys of different silicon contents, and pure silicon. He has investigated the influence of the addition of other elements, *e.g.*, titanium, nickel and beryllium on the physical properties and corrosion resistance.

The Present Position in the Manufacture of Malleable Iron Castings in Germany

By Dr.-Ing. R. Stotz.

The production of malleable iron was introduced into Germany at the beginning of the 19th century and followed British practice. It was not before the second half of the 19th century that the German malleable foundries developed rapidly, and this was considerably facilitated when melting in crucibles gave way to the cupola process. Now 83 per cent. of the total production originates from the cupola furnace.

The improvements of the cupola melting process, made in recent years, permit the production of a high-quality product, using the cheapest charge, which may only be made up of steel scrap, gates and ferro-alloys. Since in light-weight construction, for instance in motor-car and aircraft construction, light sections with a wall-thickness of 6 to 8 mm. are frequently applied, new standard test-bars with corresponding diameter must be developed. The white-heart malleable iron, which is more commonly used in Germany, exhibits far better tensile properties in thin sections than in sections with greater wall-thickness; this material is, therefore, especially adapted for light-weight construction. Large-scale tests carried out by the Malleable Iron Division of the German Foundrymen's Association indicate that the German standard tensile test-bar with a gauge length of L = 5 d is too long, it being impossible to cast it absolutely free from pipe. These micro-pipes can, however, be avoided, if a gauge length of L = 3 d is adopted and new standard test-bars are utilised, having diameters of 6, 9, 12, 15 and 18 mm. respectively. Such test-bars are dense throughout and exhibit an ultimate strength which is 50 to 80 per cent. higher than with the long DIN proportionality bars. By dividing the gauge lengths of both test-bar types in centimetres, all portions of the short bars showed a higher elongation than the corresponding portions of the DIN bar, the increase amounting up to 70 per cent. The average elongation at fracture of the DIN bar with a diameter of 16 mm. was 5.6 per cent. in the case of a gauge length of L = 5 d = 80 mm.; for a gauge length of L = 3.2 d = 50 mm. it amounted to 6 per cent. when measured symmetrically to the centre of the bar, and to 6.2 per cent. when measured in symmetric position to the point of fracture. Thus, with the DIN test-bar no essential influence of the gauge length is observed, and it may be inferred that the superior values obtained with the shorter test-bars do not originate from the shorter gauge length, but from the higher density of the casting. This may lead to the conclusion that the hitherto prevailing DIN test-bar with a diameter of 12 mm. and a gauge length L = 5 d = 60 mm. is not adapted to reflect the true tensile properties of the malleable iron.

Similarly, with open-hearth melts, the tensile properties of the castings have improved, and in special malleable iron with a tensile strength of about 32 to 35 tons per sq. in., an elongation of 4 to 6 per cent. is invariably obtained.

In the oil-fired rotary furnace a special-grade iron with low sulphur and silicon content has been produced, which, with a wall-thickness of 4 to 8 mm., is distinguished by good weldability (fittings and automobile castings), a good ductility (18 to 22 per cent. elongation) and a good tensile strength of about 24 to 27 tons per sq. in.

By heat-treating the whiteheart malleable iron, possessing a rather heterogeneous structure with thick-walled sections, a considerably better homogeneity is attained. The casting exhibits then a structure made up of globular cementite and possesses good machining properties. By heat-treating blackheart iron a tensile strength of about 48 tons per sq. in. and an elongation of 5 per cent. are obtained.

The introduction of the light-weight refractories for malleable furnaces has resulted in appreciable savings of fuel. Since their weight per unit of volume amounts to only half that of fireclay bricks used formerly, the heat accumulated in the annealing chambers is substantially decreased, the heating time becomes shorter and a reduction of the furnace area may be effected.

The ring-tunnel furnace (Ringtunnelofen) proved to be a satisfactory unit, for a monthly production of 36 tons of malleable iron with a consumption of 70 to 75 per cent. of lignite briquettes. The obsolete flat grate furnace is frequently remodelled into semi-producer type furnaces using coal breeze or lignite, or adapted to the use of producer or town's gas, the latter being the simplest kind of fuel; with well isolated furnaces only 50 to 60 cub. m. of gas are consumed for 100 kg. of castings. The application of the underfeed furnace and of the electric furnace is being developed.

Malleable iron lends itself to such a variety of products that new applications are always being made. This is due to its advantages, such as high surface finish, accuracy of dimensions, good tensile strength and ductility. The chief trades using malleable castings are the motor-car and bicycle industries, aircraft construction and the like.

The Sectional Sensitivity of Cast Iron

By J. Jungbluth.

A short survey of the problem of the sectional sensitivity of cast iron is given, with special reference to the author's previous Paper* summary. The object of this Paper was to determine the relationship between the sectional sensitivity of test castings and test-bars. Boxes of 15, 30, 50 and 70 mm. wall thickness and 300 mm. in length were chosen as test-pieces, the inner core being 300 by 300 mm. The diameters of the test-bars were also 15, 30, 50 and 70 mm. In order to investigate the relationship between the strength properties of attached test-bars and castings, a test-bar of 30 mm. diameter was poured attached to the 30 mm. wall of a casting within a distance of 30 mm. This test-bar was connected with the casting by an upper and lower runner. The sectional sensitivity was investigated by determining the tensile strength and Brinell hardness.

The following results were found: (1) The sectional sensitivity of separately cast test-bars with the same diameter as the wall-thickness of the castings, and tested according to their tensile strength, is 2½ to 3 times as great as that of the castings. In particular, castings of high-duty cast iron, viz., with a tensile strength of more than 15 to 18 tons per sq. in., showed only a slight sectional sensitivity which in practice in most cases can be neglected.

If the sectional sensitivity is tested according to Brinell hardness a smaller percentage diminution of the Brinell hardness with increasing wall-thickness is found, compared with the tensile strength. Therefore the Brinell test should if possible not be employed in determining the sectional sensitivity.

Very remarkable results were obtained by a comparison of the tensile strength of the 30 mm. attached test-bar and the tensile strength of the 30 mm. wall. If the quotient

$$\frac{\text{Tensile strength of attached bars}}{\text{Tensile strength of the wall thickness}}$$

is compared with the tensile strength of the wall, in respect of the C + Si value, it can be seen that there exists a considerable difference between the tensile strength of the attached bar and the tensile strength of the wall for castings of smaller tensile strength, *i.e.*, those with a high C + Si value (very high value for the quotient). Both values approximate each other more closely with an improvement in the iron (small value for the quotient). For high-duty cast iron, viz., with a tensile strength over 15 to 18 tons per sq. in., these values are so much alike, that the tensile strength of the attached bar gives with a sufficient accuracy the tensile strength of the wall of the same thickness. As this high-duty cast iron has also a small sectional sensitivity in test-castings, the conclusion can be drawn that in the case of high-duty cast iron the attached test-bar gives a sufficiently exact value for the tensile strength in the different wall dimensions of the castings.

In a comparison between the tensile strengths of the separately-cast 30 mm. bar and the bar from a wall thickness of 30 mm., a favourable result could not be obtained as the values scatter too much.

The estimation of the results according to Dübi's method, with the help of the hardness characteristic ("Härtecharakteristik"), failed to confirm the usefulness of the method mentioned as far as these tests are concerned.

* Foundry Trade Journal, July 9, p. 21, and July 16, 1936, p. 45.

The Graphite Structure of Grey Cast Iron and Its Modification

(*Concluded from page* 251.)

oxidising and reducing conditions made crucible metal similar to cupola metal in structure.

It appears that the difficulty of producing refined structures from the cupola is due to coke producing a reducing action, possibly locally, on inclusions previously formed by oxidation, and hence rapid melting under oxidising conditions is indicated. The effect of reducing conditions would be to reduce FeO in the inclusions and make them richer in SiO_2 and TiO_2 raising the melting point.

Mechanical Strengths of Super-cooled Graphite Irons

Much information has been obtained on the strengths of supercooled graphite irons and much more remains to be done. Table I gives differences in mechanical properties of two irons, A and B, of similar composition apart from the fact that B has been treated to give refined graphite.[13]

The effect of supercooled graphite on deflection is of considerable importance. Speaking broadly, at a given load the total deflection of a supercooled graphite iron is less than that of a coarse graphite iron, but the supercooled graphite iron usually withstands a greater breaking load before fracture, accompanied by a greater deflection at fracture. The supercooled graphite iron is therefore stiffer than the flake graphite iron, but by taking the fullest advantage of alloy additions, the matrix can be made tougher. Fig. 7 shows total deflection and set curves on a 3-in. bar taken on 18 in. centres, untreated and treated.

The fatigue properties of supercooled graphite irons have not yet been examined except in the case of a Silal iron containing 5 per cent. silicon on which Gough and Pollard[14] report an endurance ratio of unity. The damping capacity of supercooded graphite irons may be expected to be less than coarse graphite irons.

Corrosion tests have not been carried out, although the work of German investigators suggests that fine graphite is not so suitable for corrosion resistance as flake graphite iron. The effects of supercooled irons on ordinary composition against heat have not yet been fully determined, neither have the effects of wear, although the supposed superiority of coarse graphite irons may arise from the fact that previous experiments on supercooled graphite have been carried out with a matrix partially or wholly ferritic.

The annual dinner of Qualcast, Limited, of Derby, was held last Saturday. Mr. V. Jobson, chairman of the company, presided, and was supported by Mr. F. S. Richardson and Major Briggs (directors). Mr. Harry Winterton, President, and Mr. John Cameron and Mr. Victor Stobie, Past-Presidents of the Institute of British Foundrymen, were amongst the guests.

Runners and Risers for Cast Iron*

HOW TO OVERCOME DEFECTS IN DIFFICULT CASTINGS

By R. F. COATES

While runners are essential on castings, risers are only required in certain cases. As the use of risers raises the cost of production by increasing the time in making, causing more returned scrap, etc., it is necessary that whenever possible their use should be curtailed. Consideration must be given to the speed of filling the mould and the direction of flow to obtain an even stream of metal to all parts of the mould, and for these reasons runners are important. They must also be so designed as to prevent dirt and dross entering the mould, and therefore care must be given to their position, size and shape.

The scope of runners can enter three categories:—(1) Slow running; (2) standard running, and (3) fast running, and each has a particular use for different castings. The principle of slow running is taken from the Ronceray method which run castings at such a speed as to allow the metal to take its liquid shrinkage as the mould slowly fills. A strainer core can be used with success on small castings of importance, to avoid dirt entering the mould, and this is shown in Fig. 1.

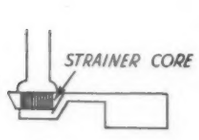

FIG 1.

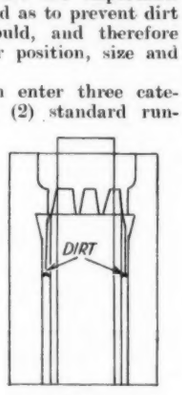

FIG 2

Runners for general engineering castings which require little or no machining come under the second class, standard running. For this class of casting the most important item to consider is the position of the runner and its ability to give an even distribution of metal to all parts of the mould. The third item of fast running covers three totally different types and is used on different classes of mould.

Light castings, such as radiators, stove grates, etc., having thin sections, must be run quickly to fill the mould successfully. Other types of castings that must be run quickly are liner castings and chilled rolls. The best way to run a liner is to use a number of small runners around the centre-bore core and to cast it vertically. As the metal drops round the mould between the core and the mould wall, it "agitates" the top of the metal as the mould fills. This keeps on the top all dirt, which finally rises into the sullage head, and does not adhere to any ledges in the mould wall (Fig. 2).

This action can be clearly seen by allowing water to run from a tap into a glass vessel (Fig. 3). The weight of a liquid's direct drop creates a space into which any foreign body is naturally drawn. To pour chilled rolls the best method employs a runner at the bottom of the mould and at a tangent so as to induce a spinning action which keeps any dirt spinning in the direction of the metal, and therefore prevents it from adhering to the mould or core. This method is shown in Figs. 4, 5 and 6. The principle of these two examples is to keep the metal "in action" with the same ultimate result, although it is done by creating the necessary movement from a different direction. In all cases where castings are highly machined, a good speed of pouring is essential to keep dirt broken and "on the move"; so that as the mould fills, the dirt will rise into the sullage head at the top.

FIG 3.

FIG.4

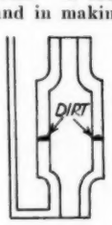

FIG.5.

Heavy Castings

The third type of casting which demands fast running is of the heavier class, such as thick weights, the disc flywheels, etc., where the top part of the mould is exposed to the heat of the metal. If not run quickly, the heat of the metal while slowly rising will destroy the bond of the sand in the top part, which will contract and crack, with the result that the mould surface will peel off. A disc flywheel is best run by a series of spaced runners on the rim. A long runner box is used for the bush and in making up, loam-cake cores should be placed to form the tops of the down gates, and a large flat piece of loam-cake should be placed where the metal pitches into the bush from the ladle. This is shown in Fig. 7.

Armed flywheels can be run on the boss with a runner on each side of the core. The metal dropping into the boss tends to hold any dirt there, which will consequently rise to the top where an allowance can be made for extra machining. Small armed pulley wheels, where the boss is often the thickest part, should be run on the arm so as not to add to an already "hot spot."

FIG.6.

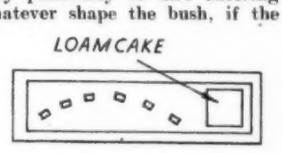

FIG.7.

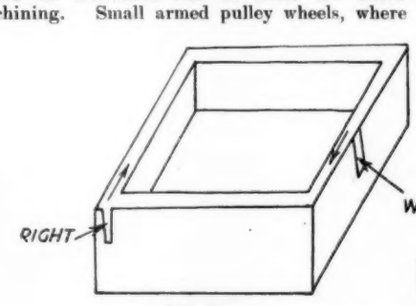

FIG. 8.

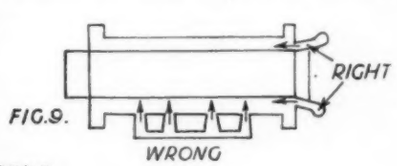

FIG.9.

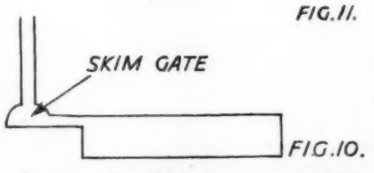

FIG.10.

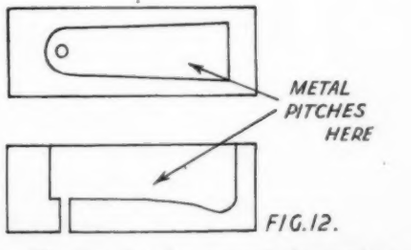

FIG.12.

FIG.11.

Multiple Running

As the number of runners are increased, so will there be a more even distribution of metal over the mould's surface, thereby producing an even temperature which is essential in avoiding shrinkage. Dirt that enters a mould through the runner is in almost every case found near to it in the casting. It is, therefore, good practice to keep runners as far from machined surfaces as possible, because the metal becomes cleaner as it travels. This fact is supported when one sees a mould cast with an open riser, for the metal which comes up through the riser will be perfectly clean. All runners should be so arranged to allow the metal to enter the mould with as little resistance as possible. If metal is directed on to a core or mould face, the bond of the sand will be burnt out, and the face will "break away" and cause a scab; this practice can also cause leakage trouble, as shown in Fig. 8.

A flanged pipe should not be run on the side for these reasons, but rather on each side of the core, thereby giving an unrestricted flow of metal (Fig. 9). Runners which are on the side of the mould should be connected by a top gate in the top part of the mould, which acts as a skimmer, and as the dirt rises into this skim-gate it allows the clean metal to flow into the mould (Fig. 10). It is necessary in all cases that the down-gate should be slightly larger in area than the runner gates adjoining the mould, to ensure that the whole runner system is full of metal at the cast.

Runner Bushes

Runner bushes should be made in such a way as to prevent any possibility of dirt entering the mould. Whatever shape the bush, if the down-gate is put in the centre, a whirling action is created and dirt is drawn into the whirl of metal and so down into the mould. Everyone is familiar with this action, after taking the plug from the bath. A runner bush should be wider and deeper at the point where the metal is poured from the ladle than at the opposite end where the metal drops through the down-gate (Figs. 11 and 12). If this rule is observed, it is possible to keep the bush full, and consequently all dirt will be kept on top of the bush head.

No dirt that has entered the mould by the runner will come up through the riser, and it has already been mentioned that metal coming through a riser is quite clean. Risers, however, should not be left open, as there is no pressure created to ensure mould and core gases taking their proper direction of escape. Some castings which require feeding or have to be rod-fed, must have risers of sufficient sizes to ensure efficient feeding, whereas in radiator castings risers are provided to act more as an outlet

(*Concluded on page* 258.)

* This Paper was awarded second prize in a Short Paper Competition organised by the East Anglian Section of the Institute of British Foundrymen.

Principles of Cast Iron Metallurgy

On March 5, 1937, Mr. J. G. Pearce addressed a meeting of the Birmingham Branch of the Institute of British Foundrymen over which Mr. G. W. Brown presided. The subject of his Paper was "Principles of Cast Iron Metallurgy," and in his opening remarks Mr. Pearce said he would attempt to answer three questions: (1) What is cast iron? (2) What does it look like under the microscope? and (3) What could be expected from it in the future?

Mr. Pearce pointed out that when one was dealing with pure iron-carbon alloys it was possible to differentiate a cast iron from a steel by its carbon content; fixing the dividing line at 1.7 per cent. carbon. Cast irons were those irons containing more than 1.7 per cent. carbon, whilst steel contained less than this amount. With the advent of low carbon irons and the use of high alloy contents, such a differentiation was impossible, and it was difficult to say whether the material was a steel or cast iron. He suggested that the microscope offered a means of differentiation and any material which contained eutectic in its microstructure could be classed as a cast iron and material which did not, could be called a steel.

The lecturer then described the structure of cast iron, first showing a number of slides of steels containing varying quantities of carbon. Mr. Pearce pointed out that carbon produced pearlite which increased in quantity as the carbon increased, and which was responsible for the strength of steel. At 0.9 per cent. carbon the structure was shown to be wholly pearlitic after which successive quantities of carbon gave that free (pro-eutectoid) cementite which made the steel harder but lower in strength. The lecturer also showed that pearlite was the major constituent in cast iron and determined its strength. White irons showed considerable quantities of free cementite whilst in grey irons cementite was replaced by free carbon which was present as graphite flakes in the structure. The free cementite was a vital factor in the strength of cast iron and could be avoided by the use of silicon which decomposed it into graphite and pearlite as shown many years ago by Prof. Turner. The aim of the founder was to adjust the silicon and carbon contents to give a totally pearlitic structure with free graphite and no free cementite. Such an iron possessed high strength. Some founders, said Mr. Pearce, in their attempt to avoid free cementite and without present knowledge, added too much silicon, with the result that some of the pearlite was broken down, giving free ferrite in the structure and a weaker iron.

Another factor which affected strength was the amount and size of the graphite flakes. The larger and more numerous the graphite the lower was the strength. This had caused founders to employ low carbon irons or modify their practice to produce fewer and smaller flakes, as was the case with the Meehanite process. In this method carbon and silicon were added to molten white iron to cause a breakdown of free cementite, resulting in the production of small graphite flakes. A number of slides of coarse and fine graphite at high magnification were shown. The increase in strength with low carbon irons usually meant higher fettling costs, more refractory sands, and necessitated better melting practice.

Mr. Pearce gave a brief description of the iron-carbon diagram and the changes taking place which produced the structure of cast iron. He also dealt with low carbon irons as used for crankshafts and pointed out that these irons were cheaper and possessed greater damping capacity than steel.

DISCUSSION

MR. G. W. BROWN (Branch-President) said that they had listened to a very interesting lecture and the Branch was indeed honoured by having Mr. Pearce to give his Paper.

MR. G. R. SHOTTON, in proposing a vote of thanks, said he thought Mr. Pearce was to be congratulated on the explicit and thorough manner in which he had given the lecture. He thought Mr. Pearce, in distinguishing cementite from ferrite, might have pointed out that graphite was associated with ferrite but did not appear near the cementite.

MR. J. H. DOLPHIN seconded the vote of thanks. Cast iron, he said, was developing into a variety of special materials and although its metallurgy was slowly becoming understood, yet it only served to show how much more there was to be learnt. He was extremely interested in the photomicrograph of the structure of a light casting and he had seen fractures of light castings in which one could see the network with the unaided eye. Previously he had thought it due to the presence of phosphide eutectic but now he realised that the pearlite was also partly responsible for the effect. He asked Mr. Pearce in what form the sulphur was present when there was not sufficient manganese to convert it all to manganese sulphide.

It was quite helpful to have the structure and analysis specified for a particular job but not always easy to carry out the specifications owing to conflicting factors. In the case of a pulley wheel, for instance, one might use a hard iron to give a pearlitic structure and high strength, but this same pearlitic iron would cause the pulley to crack in the mould, due to increased shrinkage.

In reply, MR. PEARCE said that many light castings of about ⅛-in. section showed a similar structure to that shown on the slide, namely, rosettes of small graphite in lakes of ferrite surrounded by pearlite and phosphide eutectic. Sulphur in excess of that required to form manganese sulphide formed iron sulphide which, having a lower melting point than iron, was thrown out of solution on solidification and tended to stabilise cementite. Iron sulphide was most detrimental in malleable cast iron as it tended to form at the grain boundaries in the annealed casting and if this network was continuous, it made the iron very brittle and destroyed its malleability.

He fully appreciated the trouble experienced with regard to the pulley, and said that the solid contraction was greater with a pearlitic iron than with an ordinary iron, and the expansion due to graphite precipitation on solidification was also less.

MR. J. J. SHEEHAN said that whilst agreeing that irons of the eutectic type were better from the point of view of minmising shrinkage, he thought that the tendency nowadays was to produce irons of the hypo-eutectic type, *i.e.*, lower in carbon content. He also thought that Mr. Pearce might have said something about the Balance Blast cupola, for he thought that this was the one cupola which tended to give consistently irons of eutectic composition.

With regard to the question of damping, he would like to point out an example of stress raising in the case of a steel bridge. Whenever soldiers pass over a steel bridge, they are told to break step for fear they might strike the natural frequency of vibration of the bridge, which would then build up and shake the structure to pieces. This did not happen if cast iron was used.

MR. PEARCE agreed that, where high tensile strengths were needed, the tendency was to produce hypo-eutectic irons, and this was what one might expect, for with a lower carbon content the graphite flakes became smaller. At the same time, one had to devise means of meeting the higher shrinkage which resulted from lowering the carbon content. These were the type of irons which had been developed for crankshafts. He would not suggest that they were better than steel, but they were good enough for the job. He thought that the decrease in strength when the irons were under fatigue, as in crankshafts, was less in the case of cast iron than with steel. He thought the example of stress raising in a steel bridge was a good one.

MR. T. H. GAMESON asked if Mr. Pearce could give him the analysis of austenitic cast iron, and also if there was any commercial prospect for these irons.

MR. PEARCE gave the analyses of three austenitic cast irons, namely, Nomag, Niresist and Nicrosilal. These irons had all been developed for use in special circumstances, and he thought there was a future for these materials, as they possessed remarkable resistance to corrosion and growth. They also were non-magnetic. At the same time, the alloy additions rendered them rather expensive.

MR. DOLPHIN said he understood the damping capacity of cast iron was due to the presence of graphite, and would like to know why low carbon irons were used.

MR. PEARCE replied that there was no doubt that irons high in carbon, such as hematite, had the highest damping capacity, and that this property decreased with lower carbon content. The irons used for crankshafts possessed the best combination of strength and damping capacity. He would advocate, however, running the carbon as near to the true cast irons as the strengths required permitted.

MR. G. W. BROWN said that cast iron recovered itself more quickly when passing through the critical speeds than did steel. MR. PEARCE agreed.

Runners and Risers for Cast Iron

(*Concluded from page 257.*)

for the gases to relieve pressure and to ensure a completely run casting than as actual risers. A riser off the machined face in the top surface of a casting will help to eliminate blow holes which are likely to form at this part of the casting.

Larger castings, such as covers, plates and mixer pans, with a large surface area, should have a "flow off" riser. This allows a considerable amount of strain to be relieved by flowing off metal at a time when the greatest pressure is exerted just as the mould is "made." The foundry worker in the course of his work knows from experience that a large percentage of scrap castings is due to incorrect running. Too much stress, therefore, cannot be laid upon the fact that careful consideration is always necessary with regard to the runner system.

Combustion Appliance Makers' Association

In the course of his presidential address at the annual meeting of the Combustion Appliance Makers' Association (Solid Fuel), held in London on March 16, LT.-COL. J. H. M. GREENLY pointed out that the Association had, during the past year, established a research department. Already it had been privileged to co-operate and help in solving problems which had been submitted to it by several important users of fuel, including one of the great railway companies. The Industrial Research Council of the British Iron and Steel Federation had also paid the department the compliment of entrusting to it some very important investigations in connection with producer-gas mains.

The annual luncheon was held, following the meeting, at the Connaught Rooms. Mr. J. Arthur Reavell, the new President, was in the chair, and there was a large and representative gathering of the fuel apparatus and fuel-producing and consuming industries. The guest of honour was Capt. H. F. C. Crookshank, M.P. (Secretary for Mines).

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ESTABLISHED 1910

The Week's News in Brief

Trade Talk

THE ADDRESS of the Office of Trade Boards has been changed to Metropole Buildings, Northumberland Avenue, London, W.C.2.

THE ADMIRALTY has placed an order with Harland & Wolff, Limited, for the construction of an aircraft carrier at their Belfast works.

SMITH'S DOCK COMPANY, LIMITED, South Bank, Middlesbrough, have booked an order for four whale catchers for Norwegian owners.

THE ANNUAL SOCIAL for the employees of the Bonnymuir and Dykehead Works of George Turnbull & Company, Limited, was held on March 12.

SAMUEL FOX & COMPANY, LIMITED, are to remodel their furnaces and install a new cooling system. The firm hope by this means to prevent blood-irritation caused to workers at the furnaces.

STEWARTS AND LLOYDS, LIMITED, have received a contract for the Central Argentine Railway to supply 700 solid-drawn galvanised-steel smoke tubes, and 10,000 solid-drawn steel boiler tube safe ends.

R. & W. HAWTHORN LESLIE & COMPANY, LIMITED, Hebburn-on-Tyne, have received an order from the Anglo-Saxon Petroleum Company, Limited, for two 12,100-ton oil tankers. The engines are to be of the Hawthorn-Werkspoor type.

THE ENGINES for the 11,500-ton motor vessel to be built by Swan, Hunter & Wigham Richardson, Limited, for the Polish America Company, of Gdynia, Poland, will be built by J. G. Kincaid & Company, Limited, of Greenock.

THE LILYBANK FOUNDRY, Dundee, formerly belonging to the Caledon Shipbuilding & Engineering Company, Limited, has been bought by Alfred E. Powrie & Son. The Ward Foundry, also of Dundee, is to be disposed of by Tulloch & Strachan, builders and contractors, of Dundee.

THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham, have completed a plant for the production of spun pipes of 2½ in. dia. in 12-ft. lengths. These are now being offered on the market. Within a few weeks they will be offering spun pipes of 2 in. dia., also in 12-ft. lengths. The company is also preparing to increase the number of its blast furnaces in blast from eight to ten.

AN EXTRAORDINARY GENERAL MEETING of the British Aluminium Company, Limited, has been called for March 31, to consider the resolution: "That the capital of the company be increased to £7,000,000 by the creation of 2,500,000 additional ordinary shares of £1 each, and that such new shares be issued at such time or times to such persons and for such consideration and upon such terms and conditions as the board may from time to time determine."

GENERAL REFRACTORIES, LIMITED, have declared a final dividend of 10 per cent., making 16 per cent. for the year ended December 31, 1936, against 15 per cent. for the previous year. The final dividend of 10 per cent. referred to above is being paid on the issued capital of £475,000, which was increased during last year from £325,000, at which it stood in the balance sheet at December 31, 1935. The company has received orders for the refractory materials for the new Turkish steelworks, the contract for which was awarded to H. A. Brassert & Company, Limited.

PARTICULARS HAVE BEEN PUBLISHED of Westwood Dawes & Company, Limited. The company was incorporated on March 6 to acquire the business carried on for several years by William Westwood and Edward Harry Dawes at Bowling Green Road and Enville Street, Stourbridge, under the style of "Westwood Dawes & Co." The business was founded in 1920. The company specialises in elevating and conveying machinery.

AT THE INVITATION of Davy Bros., Limited, last week, officials and engineers of Sheffield and district steelworks saw a number of films showing the latest design of continuous steel sheet and strip rolling mills in operation. These mills, which have been recently installed in leading American steelworks, were built by the United Engineering & Foundry Company, of Pittsburgh, U.S.A., with whom Davy Bros., Limited, have entered into a working arrangement.

CUEST KEEN BALDWINS IRON & STEEL COMPANY, LIMITED, is to restart a blast furnace at Dowlais. An official statement says that as an entirely temporary measure to help relieve the present shortage of pig-iron, more particularly in South Wales, the company, in conjunction with the British Iron and Steel Federation, has made arrangements to bring into operation one of the old blast furnaces at Dowlais. Work will be commenced at once on mechanical repairs and adjustments. It is hoped, provided raw material can be obtained, to manufacture pig-iron by the summer of this year.

Personal

THE EARL OF DUDLEY has been elected chairman of Horseley Bridge & Thos. Piggott, Limited, constructional engineers and ironfounders, of Tipton.

MR. S. THOMSON, of the Dalzell Steel Works of Colvilles, Limited, has been appointed works manager of the Lanarkshire Steel Company, Limited, Motherwell. He has succeeded the late Mr. George Thom.

FOLLOWING THE FUSION OF INTERESTS, reported in our issue of February 4, between the United Engineering & Foundry Company of Pittsburgh, U.S.A., and Davy Bros., Limited, of Sheffield, Mr. K. C. Gardner, Vice-President of United Engineering & Foundry Company has joined the board of Davy Bros.

SIR ALEXANDER M. KENNEDY, chairman and managing director of the Fairfield Shipbuilding & Engineering Company, Limited, will resign the managing directorship at the end of this month. He will continue as chairman. Mr. George W. Barr and Mr. Robert Strachan, who are directors of the company, have been appointed joint managing directors.

Wills

WORMALD, ARTHUR, managing director of Rolls-Royce, Limited	£24,010
BARR, JOHN DOWNIE, coppersmith and brassfounder, of Greenock	£3,399
HELM, WALTER WILSON, director of Francis Helm, Limited, ironfounders, of Burnley	£39,690
WIGHAM, JOHN, founder of John Wigham & Sons, Limited, engineeers and ironfounders, of Hylton, Sunderland ...	£4,230
OSBORN, IAN S., director of Samuel Osborn & Company, Limited, steel and tool manufacturers, of Sheffield	£19,535

Obituary

MR. SIDNEY TOWNEND BATLEY, a director of Greenwood & Batley, Limited, engineers, of Leeds, has died.

MR. CHARLES W. BATES, head of William Bates, Son & Company, textile engineers, Sowerby Bridge, died last week, aged 65.

THE DEATH HAS OCCURRED, at the age of 55, of Mr. Percy Clay, a director of Cliffe & Company, Limited, Longroyd Bridge Ironworks, Huddersfield. He was made a director of the company last March.

DR. ELIHU THOMSON, the American electrical engineer, died at his home in Massachusetts on March 13, at the age of 83. One of the founders of the British Thomson-Houston Company, Dr. Thomson was credited with more than 700 electrical inventions.

MR. BENJAMIN GRAHAM, senior partner in the firm of Benjamin Graham, ironfounders of Waterford, died last week. He had been connected for seventy years with the firm, which was founded 145 years ago. The firm was the first to light the City of Waterford with gas and Waterford claims to have been the first city in the world that was so lighted.

MR. WILLIAM CLARK, who was for 15 years managing director of Vickers Works, Sheffield, retiring in 1925, has died at his residence at Skelmorlie, Ayrshire. Mr. Clark was Master Cutler in 1920. His association with the Sheffield steel and engineering trades as the managing director of Vickers' River Don Works did not start until 1911, when he was 57 years of age. Mr. Clark was born in Mauchline, Ayrshire. In 1873 he joined the accountants' staff of the Steel Company of Scotland, Limited, leaving two years later to take charge of a small wire mill at Brighouse, Yorkshire. He was offered another appointment with the Steel Company of Scotland, and, accepting this offer, he became accountant, then secretary, and finally manager of the company. He remained with them until the end of 1910, when he resigned to take over his office as manager of Vickers' Sheffield works. Shortly afterwards he was appointed a local director of Vickers. This was followed by his election as a full director of the company. He was a Past-President of the West of Scotland Iron and Steel Institute, and was the first chairman of the Steel Makers' Association in Scotland. At the end of 1925 Mr. Clark, then 71 years of age, retired from his position as managing director of Vickers' Sheffield works, and shortly afterwards went to live at Skelmorlie.

Contracts Open

Bearstone, March 30.—4,000 yds. of 12-in. dia. spun-iron rising main, for the Nantwich Rural District Council. The Engineer, 21, Pillory Street, Nantwich.

Bearstone, March 30.—Two electrically-operated horizontal multi-stage centrifugal pumps capable of delivering 10,000 galls. per hr., with motors, etc., for the Nantwich Rural District Council. The Engineer, 21, Pillory Street, Nantwich.

Carlisle, March 29.—Machine tools, etc., for the Town Council. The City Electrical Engineer, Electricity House, Castle Street.

Silverdale, April 1.—3,850 yds. of 3-in. and 6-in. spun-iron concrete-lined water mains and valves, etc., for the Lancaster Rural District Council. Mr. H. B. Ward, consulting engineer, 26, North John Street, Liverpool, 2. (Fee £5 5s., returnable.)

West Alvington, April 1.—1,900 yds. of spun-iron water mains from 3-in. to 7-in. dia., for the Kingsbridge Rural District Council. Lemon & Blizard, consulting engineers, 24, Lockyer Street, Plymouth. (Fee £3 3s., returnable.)

Whitefield, March 31.—Ironwork, for the Urban District Council. Mr. C. F. Porter, clerk, Town Hall, Whitefield, Lancs.

Wigton, April 5.—7,400 yds. of 3-in., 2,500 yds. of 4-in. spun or vertically cast-iron water mains, and 3,000 yds. of 4-in. steel pipes, for the Rural District Council. Mr. D. Easton, clerk, Rural District Council Offices, George Street, Wigton, Cumberland.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

F. Maxen & Sons, Limited, 27, Brimsdown Avenue, Brimsdown, Middlesex.—Capital, £2,000. Ironfounders, mechanical engineers, etc. Directors: F. Maxen and Miss D. Maxen.

Wilkes Berger Engineering Company, Limited.—Capital, £100,000. Directors: F. W. Wilkes, Sparrow's Best, Wood Norton, near Evesham; M. M. Berger, C. Berger, J. R. Parr and A. E. Beishon.

Forthcoming Events

Institute of British Foundrymen

MARCH 27.

Newcastle-upon-Tyne Branch:—Annual General Meeting; Report on the work of the Technical Committee by E. B. Ellis and G. Elston at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

APRIL 1.

Sheffield Branch:—Annual general meeting; "Pig-Iron." Paper by R. C. Tucker, M.A., at King's Head Hotel, Change Alley, Sheffield, at 7.30 p.m.

APRIL 2.

Birmingham Branch:—Annual general meeting; Short Paper Competition, at the James Watt Memorial Institute, York House, Great Charles Street, Birmingham, at 7.30 p.m.

APRIL 3.

Lincolnshire Section:—Annual general meeting, at the Technical College, Monks Road, Lincoln, at 7 p.m.

Lancashire Branch:—Annual general meeting; Reports of the Sub-Committees on (1) Two Leaded Gunmetals and (2) Dimensional Tolerances, at the Engineers' Club, Albert Square, Manchester, at 4 p.m.

Foundry Equipment and Furnaces

We specialise in the most modern and efficient Foundry Plant. Our experience in Continuous Castings Systems will be of great value to you.

Our furnaces operate on almost every type of fuel.

Our technical staff at your service.

Coggon Foundry Equipment Ltd.

Shay Lane, Ovenden,
HALIFAX, YORKS.

Telegrams: "Coggon, Halifax" Telephone: 2423

Raw Material Markets

Stocks of pig-iron are not to be found, and consumers are relying on the tonnage that is despatched to them by the makers. Users' needs are being met, but any further worsening of the position would handicap production. An interesting view on the supply of steel was expressed by Mr. Alexander Williamson, general manager of the Steel, Peech & Tozer branch of the United Steel Companies, Limited, to a gathering of the works council of the branch on Friday. Although there was some tightness, it was not correct to say that there was a definite shortage, he said. Knowing there was some tightness, people were asking for a good deal more than they required, in the hope that, by asking for a lot, they would get something like the amount they really wanted. Mr. Williamson said that it would make it easier for everyone if people asked only for what they needed. The scrap market still lacks information with regard to selling prices.

Pig-Iron

MIDDLESBROUGH.—In view of their well-filled order-books and the general uncertainty with regard to future prices, makers hesitate before considering new business, even for the second half of the year. Meanwhile, deliveries are being despatched on as good a scale as is possible, and the current quotations of 81s. for Cleveland No. 3 G.M.B. iron, 83s. 6d. for No. 1 foundry, and 80s. for No. 4 foundry and No. 4 forge are only nominal. Inquiries for hematite are also being refused, as makers have fully disposed of their outputs as far ahead as they are inclined to negotiate at the present time. For delivery up to the end of May, East Coast mixed numbers are quoted at 97s. 6d. per ton, delivered on the North-East Coast, 103s. in Sheffield, and 108s. 6d. in the Midlands, subject to 5s. per ton rebate.

LANCASHIRE.—Business is confined to the renewal of expired contracts, and new trade in the true sense of the term cannot be considered. Consumers generally are well placed for work, and would willingly purchase further supplies if that were possible. For delivery to users in the Lancashire price zone, current offers of Staffordshire and Derbyshire No. 3 foundry iron are on the basis of 89s. per ton, with Northamptonshire at 87s. 6d. and Derbyshire forge iron at from 84s. to 86s., according to the class of consumer. West Coast hematite is quoted at 106s., with East Coast at 105s., both delivered equal to Manchester, and subject to a rebate of 5s. per ton. Supplies of Scottish foundry iron are difficult to obtain at around 106s. per ton, delivered in the Manchester area.

MIDLANDS.—While most users are well covered for supplies, there are many who have only meagre stocks, and who are not fixed up for additional supplies. They are accordingly relying on day-to-day deliveries. Even consumers who have covered their future requirements find that deliveries are behind schedule in some cases. For delivery to Birmingham and Black Country stations, Northamptonshire No. 3 iron is quoted at 83s. 6d., with Derbyshire and Lincolnshire No. 3 at 86s. per ton. There is an increased demand for low-phosphorus iron at £5 to £5 15s., but supplies are being rapidly taken up. Medium-phosphorus iron is at £4 10s. to £5, with refined iron at a minimum of £6 17s. 6d. The controlled quotations for hematite are £5 9s. 6d. for West Coast mixed numbers, £5 8s. 6d. for East Coast No. 3, and £5 8s. for Welsh mixed numbers, delivered to stations in the Midlands. Owing to the scarcity of supplies, business is restricted to occasional renewals of expired contracts.

SCOTLAND.—Consumers are not getting their full contract supplies delivered, and the outlook would appear to indicate little improvement. No. 1 foundry is quoted at 90s. 6d. and No. 3 at 88s., both f.o.t. furnaces. No. 3 Cleveland iron is at 84s. at Falkirk, and 87s. at Glasgow. It is difficult to obtain even small tonnages of this iron, however, and the prices are thus purely nominal. Mixed numbers of hematite are quoted at 98s., with basic, British and Indian, at 82s. 6d., f.o.t. steelworks, and subject to a rebate of 5s. per ton.

Coke

Higher prices are now quoted for supplies of foundry coke, the figure for Durham coke being around 28s. at ovens. For delivery to Birmingham and district, best Durham coke is quoted at 45s. and upwards, and Welsh coke is from 45s. to 56s. per ton. No surprise would be occasioned if these figures were to be advanced still further.

Steel

It remains exceedingly difficult to place new orders for any description of steel. Outputs of semi-finished steel have been disposed of for several weeks ahead, while imports from the Continent are so small as to make little difference to the insistent demand. Deliveries of finished steel from the Continent are much behind schedule, and this has caused still more inconvenience to home users.

Scrap

Details of the new control scheme for iron and steel scrap have still to be issued. As a result, markets generally are quiet, and business only involves small parcels for early delivery. There is a good demand, but, until the new price levels are announced, trade is likely to be restricted.

Metals

An easier tone has developed on the non-ferrous metal markets, and prices have declined in consequence.

Copper.—While trade demand continues to be on a good scale, the market has been rather quieter during the past week. The February statistics were not particularly interesting, and indicated that production is slowly coming up to the level of consumption. However, the supply position is still tight, and little relief can be expected for some considerable time, as many large orders are due to be met in the near future. In spite of the disturbed relationships between employer and employed in many branches of industry in the United States, activity is at a high rate.

Daily market prices :—

Cash.—Thursday, £74 10s. to £74 12s. 6d.; Friday, £72 8s. 9d. to £72 10s.; Monday, £69 10s. to £70; Tuesday, £68 10s. to £68 12s. 6d.

Three Months.—Thursday, £72 16s. 3d. to £72 17s. 6d.; Friday, £71 10s. to £71 12s. 6d.; Monday, £68 10s. to £68 11s. 3d.; Tuesday, £67 13s. 9d. to £67 15s.

Tin.—An air of uncertainty surrounds this market, and many forecasts as to the future have been put forward. Although there would really appear to be no substantial ground for the statement, it is strongly rumoured that the restriction scheme is to be temporarily abandoned. A meeting of the International Tin Committee was held last Thursday, and it was expected that quotas would again be raised, but no statement whatsoever has been forthcoming as to the trend of discussion at the meeting. It is reported that the absence of any decision by the International Tin Committee created no surprise in Holland. The Committee is aware that a further rise of export quotas would not only be useless, but would, in the present circumstances, have an adverse psychological effect on the market by forcing up prices instead of reducing them.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £300 10s. to £301; Friday, £297 to £298; Monday, £282 to £282 10s.; Tuesday, £285 to £285 10s.

Three Months.—Thursday, £293 15s. to £294; Friday, £288 10s. to £289; Monday, £277 5s. to £277 15s.; Tuesday, £279 5s. to £279 10s.

Spelter.—Consumption continues to be on a good scale, and the general tone of the market is firm. The weekly review of the metal markets issued by Rudolf Wolff & Company states that "the market opened fairly firm, but the higher level brought out substantial selling and liquidation, in consequence of which prices have declined rather sharply. Consumption is reported to be very satisfactorily maintained, for active conditions continue in the shipbuilding and engineering trades, as also, although not quite to the same extent, in the galvanising industry. The price, however, is high, even allowing for the setback which has occurred, and at current levels production should undoubtedly be stimulated. Speculative operations have been on a very reduced scale, for there is little or nothing just now in the situation which should warrant a further advance; on the other hand, there seems no prospect of an important decline, although prices may ease a little further if the market is unsupported. In the United States, the market remains quietly steady and the price unchanged at 7.50c. East St. Louis."

Official quotations were as follow :—

Ordinary.—Thursday, £34 2s. 6d.; Friday, £33 2s. 6d.; Monday, £30 5s.; Tuesday, £30 12s. 6d.

Lead.—This market has also been quieter, although the undertone remains sound and the outlook is quite satisfactory. Buying in the United States has increased and under the existing sales quota available supplies are insufficient to cope with the demand. The price has decreased to 7 cents per lb., New York.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £32 18s. 9d.; Friday, £31 18s. 9d.; Monday, £30 17s. 6d.; Tuesday, £30 12s. 6d.

Company Reports

Hopkinsons, Limited.—Final dividend of 7½ per cent., making 10 per cent. for the year.

General Refractories, Limited.—Final dividend of 10 per cent., making 16 per cent. for 1936.

North British Locomotive Company, Limited.—Profit for 1936, £5,712; debit balance on profit and loss is now £113,779.

Parkinson & Cowan, Limited.—Dividend on the 7 per cent. cumulative preference shares for the half-year to March 31, 1936.

International Nickel Company of Canada, Limited.—Net profit for 1936, $36,865,526; preference dividends, $1,933,898; dividends on the common shares for 1936 totalling $1.30 a share.

Ley's Foundries & Engineering, Limited.—Dividend on the 5 per cent. cumulative preference stock for the period from January 22 to March 31, 1937, at the rate of 5 per cent. per annum.

Craven Bros. (Manchester), Limited.—Net profit for 1936, £40,717; brought in, £3,324; interim dividend, £15,000; final dividend of 7½ per cent., making 12½ per cent., £22,500; carried forward, £6,542.

Federated Foundries, Limited.—Dividend on the ordinary shares of 2½ per cent., together with the payment of the preference dividend at the rate of 5 per cent. per annum for the period from date of allotment to December 31 last.

Hadfields, Limited.—Final dividend of 10 per cent. on the ordinary shares, making a total of 13¾ per cent. for the year. The directors also propose that a capital distribution of 1s. per share be paid to the ordinary shareholders out of reserves resulting from profits on the sale of investments.

British Aluminium Company, Limited.—Profit for 1936, including the amount brought forward and after taxation and debenture interest, and setting aside £50,000 to depreciation reserve and £50,000 to the reserve fund, £361,158; dividend of 10 per cent. for the year on the ordinary shares; carried forward, £71,158.

Company Meeting

Presiding at the second general meeting of Sanbra, Limited, COLONEL C. F. HITCHINS (chairman) said that the past year was one of great progress, in completing the main part of the reorganisation programme, and in effecting a substantial increase in turnover. This increase was over 28 per cent. on the previous year's figures, which was a satisfactory performance in view of the fact that they were for some time working under great difficulties. Their pressing plant was disorganised to an appreciable extent due to the introduction of additional presses, while at the foundry, the building contractors were in possession for practically six months. Extensions to their West Bromwich works included the purchase of freehold land and the erection thereon of a new foundry. This extension had enabled them to double their tonnage output capacity. At their press works, Perry Barr, they had considerably increased their hot pressing plant. At Sanbra Works, Aston Hall Road, additional plant had been added to the machine shops and tool room.

Reason for Higher Metal Prices

In reply to a question in the House of Commons by Mr. Arthur Henderson, Mr. Neville Chamberlain, Chancellor of the Exchequer, said that the fundamental cause of the rise in price of iron, steel and non-ferrous metals was neither armaments nor speculation, but the rapid progress towards economic recovery over a large part of the world. The position was being carefully watched, he said, but Mr. Henderson attached an exaggerated importance to the demands of the armaments programme of the Government. These were only a part of the total British demand, and that, in turn, was a small fraction of the world demand.

For **"easy stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

Please address all enquiries to the nearest Sales Office :

GENERAL REFRACTORIES LTD.,

Genefax House, Sheffield

Telephone : *Sheffield 31113 (6 lines).*

Telegrams : *"Genefax, Sheffield."*

LONDON OFFICE: Russell House, Adelphi, W.C.2.
Telephone: Temple Bar 7361. Telegrams: "Genefax, Rand-London." Mr. A. C. Turner.

SCOTTISH OFFICE: 48, West Regent Street, Glasgow. Telephone: 3009. Telegrams: "Genefax, Glasgow." Mr. C. A. G. Thomson.

MANCHESTER OFFICE: 9, Albert Square, Manchester, 2. Telephone: Blackfriars 6130. Telegrams: "Genefax, Manchester." Mr. S. G. Throssell.

SOUTH WALES OFFICE: Metropole Chambers, Wind Street, Swansea. Telephone: 3680 Telegrams: "Genefax, Swansea." Mr. D. Hood-Williams.

CARDIFF OFFICE: 17, Windsor Place, Cardiff. Telegrams: "Genefax, Cardiff." Mr. F. E. Rutter.

MIDDLESBROUGH OFFICE: Halifax Buildings, Exchange Place.
Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." Mr. C. Souness.

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Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

RAW MATERIALS—PRICE LIST

(Tuesday, March 23, 1937)

COPPER

	£ s. d.
Standard cash	68 10 0
Three months	67 13 9
Electrolytic	74 0 0
Tough	74 5 0
Best selected	75 15 0
Sheets	106 0 0
India	85 10 0
Wire bars	76 0 0
Ingot bars	76 0 0
H.C. wire rods	79 10 0
Off. av. cash, Feb.	59 5 6
Do., 3 mths., Feb.	59 6 9
Do., Sttlmnt., Feb.	59 5 3
Do., Electro, Feb.	64 11 10½
Do., B.S., Feb.	64 13 9
Do., wire bars, Feb.	65 3 6
Solid drawn tubes	15½d.
Brazed tubes	15½d.
Wire	11½d.

BRASS

Solid drawn tubes	13⅜d.
Brazed tubes	15½d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	11½d.
Yellow metal rods	8½d.

TIN

	£ s. d.
Standard cash	285 0 0
Three months	279 5 0
English	285 0 0
Bars	287 0 0
Straits	286 10 0
Australian	—
Eastern	286 5 0
Banca	285 10 0
Off. av. cash, Feb.	233 19 7½
Do., 3 mths., Feb.	234 16 8½
Do., Sttlmt., Feb.	233 19 6

SPELTER

	£ s. d.
Ordinary	30 12 6
Remelted	29 15 0
Hard	26 10 0
Electro 99.9	33 5 0
English	31 10 0
India	26 5 0
Zinc dust	30 10 0
Zinc ashes	10 10 0
Off. aver., Feb.	25 4 5½
Aver. spot, Feb.	25 2 5½

LEAD

	£ s. d.
Soft foreign, ppt.	30 12 6
Empire (nom.)	31 12 6
English	32 15 0
Off. aver., Feb.	28 6 2⅝
Aver. spot, Feb.	28 6 4⅛

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	47 5 0 to 47 15 0
Do., V.M. ex-whse.	47 5 0 to 47 15 0
Rods	49 0 0

ANTIMONY

	£ s. d.
English	88 0 0 to 89 0 0
Chinese, ex-whse.	76 0 0
Crude, c.i.f. (nom.)	42 0 0

QUICKSILVER

	£ s. d.
Quicksilver	14 7 3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	9 5 0
45/50%	10 15 0 to 12 0 0
75%	15 15 0 to 17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	4/6 lb.
Tungsten metal powder—	
98/99%	4/7½ lb.
Ferro-chrome—	
2/4% car.	31 17 6
4/6% car.	21 10 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	32 10 0
Max. 1% car.	35 15 0
Max. 0.5% car.	36 10 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	7/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£13 15 0 to 14 5 0
76/80% packed	£14 15 0 to 15 5 0
76/80% export	£13 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 3/16 in. 1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/– lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	3 8 0	to 3 10 0
Mixed iron and steel	3 5 0	to 3 7 6
Heavy cast iron	3 8 0	to 3 10 0
Good machinery	4 2 6	to 4 5 0
Cleveland—		
Heavy steel	3 2 0	to 3 9 0
Steel turnings	—	
Heavy cast iron	3 17 6	to 4 2 6
Heavy machinery	4 0 0	to 4 5 0
Midlands—		
Short heavy steel	3 12 6	to 3 15 0
Light cast-iron scrap	3 2 6	
Heavy wrought iron	3 17 6	
Steel turnings	2 5 0	
Scotland—		
Heavy steel	3 4 6	to 3 7 0
Ordinary cast iron	4 1 0	
Cast-iron borings	2 2 6	
Wrot-iron piling	4 0 0	
Heavy machinery	4 6 3	

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	60 0 0
Brass	36 0 0
Lead (less usual draft)	28 10 0
Tea lead	24 0 0
Zinc	23 0 0
New aluminium cuttings	74 0 0
Braziery copper	54 0 0
Gunmetal	56 0 0
Hollow pewter	200 0 0
Shaped black pewter	150 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	83/6
,, No. 3	81/–
,, No. 4	80/–
Forge No. 4	80/–
Hematite No. 1	98/–*
Hematite M/Nos.	97/6*

N.W. Coast—

Hem. M/Nos. d/d Glas.	98/–*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	135/–

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	83/–
,, No. 3 fdry.	86/–
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/–
,, fdry. No. 3	86/–
,, fdry. No. 1	89/–

Scotland—

Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/–
Cleveland No. 3, Glasgow	87/–
,, ,, Falkirk	84/–
Scottish hem. M/Nos. d/d	98/–*

Sheffield (d/d district)—

Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	89/–
Staffs fdry. No. 3	89/–
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/–
Glengarnock, No. 3	106/–
Clyde, No. 3	106/–
Monkland, No. 3	106/–
Summerlee, No. 3	106/–
Eglinton, No. 3	106/–
Gartsherrie, No. 3	106/–
Shotts, No. 3	106/–

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)		11 17 6
Nut and bolt iron	10 5 0	to 10 15 0
Hoops		12 15 0
Marked bars (Staffs) f.o.t.		14 7 6
Gas strip		12 15 0
Bolts and nuts, ¾ in. × 4 in.		17 10 0 and up.
Steel—		
Plates, ship, etc.	9 10 6	to 9 13 0
Boiler plts	10 0 6	to 10 3 0
Chequer plts.		11 3 0
Angles		9 3 0
Tees		10 3 0
Joists		9 3 0
Rounds and squares, 3 in. to 5½ in.		10 3 0
Rounds under 3 in. to ¼ in. (Untested)		9 10 0
Flats—8 in. wide and over		9 8 0
,, under 8 in. and over 5 in.		9 13 0
Rails, heavy	8 5 0	to 8 10 0
Fishplates		12 10 0
Hoops (Staffs)		10 5 0
Black sheets, 24g. (4-t. lots)		14 0 0
Galv. cor. shts. (,,)		17 0 0
Galv. flat shts. (,,)		17 10 0
Galv. fencing wire, 8g. plain		16 0 0
Billets, soft		6 5 0
Sheet bars	6 2 6	to 6 10 0
Tin bars	6 2 6	to 6 10 0

PHOSPHOR BRONZE

	Per lb. basis
Strip	15d.
Sheet to 10 w.g.	16d.
Wire	16½d.
Rods	17d.
Tubes	21½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/–
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
to 10g.	1/7½ to 2/2½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/6½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	23.76
No. 2 foundry, Valley	22.00
No. 2 foundry, Birm.	18.38
Basic, Valley	21.50
Malleable, Valley	22.00
Grey forge, Valley	20.50
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	39.00
Billets	34.00
Sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Chicago	2.15
Steel bars	2.20
Tank plates	2.05
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.40
Wire nails	2.50
Plain wire	2.60
Barbed wire, galv.	3.05
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	32/6 to 33/–
,, furnace	27/– to 28/–
Durham foundry	28/–
,, furnace	26/– to 27/–
Scotland foundry	28/–
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	21/6 to 23/6
,, 28×20 ,,	43/– to 47/–
,, 20×10 ,,	30/– to 31/–
,, 18¾×14 ,,	22/– to 23/–
C.W. 20×14 ,,	17/6 to 18/9
,, 28×20 ,,	35/6 to 35/9
,, 20×10 ,,	25/3 to 25/9
,, 18¾×14 ,,	18/3 to 19/3

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£10 10 0 to £11 10 0
Bars-hammered, basis	£18 10 0 to £20 0 0
Bars and nail-rods, rolled, basis	£17 10 0 to £18 10 0
Blooms	£14 0 0 to £14 10 0
Keg steel	£26 0 0 to £29 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£14 0 0 to £15 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 9.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Mar.	18	..	74	10	0	inc.	60/-
,,	19	..	72	8	9	dec.	41/3
,,	22	..	69	10	0	,,	58/9
,,	23	..	68	10	0	,,	20/-

Standard Tin (cash)

			£	s.	d.		
Mar.	18	..	300	10	0	inc.	95/-
,,	19	..	297	0	0	dec.	70/-
,,	22	..	282	0	0	,,	300/-
,,	23	..	285	0	0	inc.	60/-

Spelter (ordinary)

			£	s.	d.		
Mar.	18	..	34	2	6	inc.	13/9
,,	19	..	33	2	6	dec.	20/-
,,	22	..	30	5	0	,,	57/6
,,	23	..	30	12	6	inc.	7/6

Lead (soft foreign, prompt)

			£	s.	d.		
Mar.	18	..	32	18	9	No change	
,,	19	..	31	18	9	dec.	20/-
,,	22	..	30	17	6	,,	21/3
,,	23	..	30	12	6	,,	5/-

Electrolytic Copper

			£	s.	d.		
Mar.	18	..	77	10	0	inc.	30/-
,,	19	..	77	0	0	dec.	10/-
,,	22	..	75	0	0	,,	40/-
,,	23	..	74	0	0	,,	20/-

Tin (English ingots)

			£	s.	d.		
Mar.	18	..	300	10	0	inc.	50/-
,,	19	..	297	10	0	dec.	60/-
,,	22	..	282	0	0	,,	310/-
,,	23	..	285	0	0	inc.	60/-

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Mar.	18	..	36	15	0	inc.	16/3
,,	19	..	35	15	0	dec.	20/-
,,	22	..	32	17	6	,,	57/6
,,	23	..	33	5	0	inc.	7/6

Lead (English)

			£	s.	d.		
Mar.	18	..	35	0	0	dec.	15/-
,,	19	..	34	0	0	,,	20/-
,,	22	..	33	0	0	,,	20/-
,,	23	..	32	15	0	,,	5/-

A COMPARISON OF SCRAP PRICES

Average Monthly Prices of Cast-Iron Scrap in the Principal Districts in the Years 1931–37

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
SCOTLAND (Heavy Machinery)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1931..	2 15 0	2 15 0	2 13 3	2 10 8	2 9 9	2 8 3	2 8 6	2 7 9	2 5 6	2 9 8	2 14 5	2 15 9	2 11 2
1932..	2 15 0	2 15 0	2 12 6	2 10 6	2 7 6	2 5 3	2 4 5	2 3 10	2 4 10	2 4 4	2 4 0	2 4 8	2 7 8
1933..	2 7 0	2 9 3	2 10 8	2 10 5	2 9 5	2 9 3	2 8 6	2 10 9	2 10 4	2 10 7	2 10 10	2 12 4	2 9 11
1934..	2 14 2	2 17 9	2 18 3	2 18 3	2 15 5	2 15 9	2 14 3	2 15 0	2 15 9	2 15 0	2 15 8	2 16 3	2 16 0
1935..	2 15 5	2 15 8	2 15 10	2 16 4	2 16 10	2 17 0	2 16 9	2 16 9	2 17 0	2 16 11	2 19 11	3 2 7	2 17 5
1936..	3 4 8	3 9 10	3 11 10	3 11 10	3 10 8	3 9 10	3 9 2	3 8 9	3 8 11	3 9 2	3 9 7	3 10 7	3 9 6
1937..	3 15 0	3 19 8	—	—	—	—	—	—	—	—	—	—	—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
N.E. COAST (Heavy Qualities)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1931..	2 10 4	3 9 8	2 9 7	2 8 3	2 6 3	2 3 8	2 2 9	2 1 9	2 1 0	2 2 1	2 9 9	2 6 6	2 5 11
1932..	2 6 3	2 5 8	2 3 0	2 0 8	1 19 0	2 1 0	1 15 9	1 15 6	1 15 6	1 15 6	1 17 4	1 19 10	1 19 7
1933..	2 1 1	2 2 2	2 4 9	2 3 5	1 18 9	1 19 6	2 0 0	2 0 0	2 1 3	2 5 8	2 7 10	2 10 1	2 5 4
1934..	2 12 7	2 15 1	2 13 7	2 11 6	2 11 11	2 13 9	2 11 0	2 10 6	2 11 3	2 11 10	2 13 9	2 13 3	2 12 4
1935..	2 12 2	2 13 0	2 12 7	2 13 0	2 12 9	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 16 10	2 12 10
1936..	3 0 0	3 1 10	3 1 8	3 2 2	3 4 6	3 3 9	3 5 9	3 4 1	3 5 11	3 6 3	3 6 3	3 7 10	3 4 2
1937..	3 10 6	3 14 9	—	—	—	—	—	—	—	—	—	—	—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
S. WALES (Heavy Cast Iron)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1931..	2 7 7	2 8 3	2 9 9	2 8 1	2 6 11	2 5 2	2 2 9	2 2 2	2 0 11	2 3 9	2 7 6	2 7 10	2 5 9
1932..	2 7 2	2 6 8	2 6 4	2 5 0	2 4 8	2 0 8	1 19 4	2 1 7	2 1 10	1 18 10	1 19 8	2 2 1	2 2 0
1933..	2 3 4	2 4 6	2 4 6	2 4 1	2 3 5	2 2 8	2 3 7	2 4 8	2 5 8	2 5 9	2 5 7	2 5 0	2 4 5
1934..	2 6 10	2 8 9	2 7 8	2 6 6	2 7 6	2 8 0	2 6 10	2 6 7	2 8 0	2 8 2	2 9 1	2 11 5	2 7 1
1935..	2 11 3	2 11 4	2 11 1	2 11 3	2 12 0	2 11 1	2 11 1	2 11 0	2 12 2	2 13 10	2 14 5	2 14 8	2 11 9
1936..	2 16 3	2 18 7	2 18 9	2 19 2	2 18 7	2 18 7	2 19 0	2 19 0	2 18 9	2 19 0	2 19 2	2 19 0	2 18 11
1937..	3 4 1	3 9 8	—	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

FOREMAN or Assistant desires change. Experienced jobbing, repetition, high-duty and ordinary cast irons. Young, keen and energetic. Guaranteed to get results.—Box 296, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager wishes to meet with a real live firm who have an up-to-date plant making quantity iron castings. A directorship would be considered. Salary required £750 to £1,000 per annum.—Box 286, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

GENERAL MANAGER wanted for iron foundry producing 20-30 tons light castings and miscellaneous small work. Must have practical and commercial experience. Write stating age, salary, and qualifications.—Box 308, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LEADING Brass Moulder, South. Permanency. Thoroughly experienced furnaces and metals. State experience and salary required.—Box 304, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REQUIRED for Brentford Area, First-class Practical Pattern Maker, to control the issue, receipt and maintenance routine of a pattern store (5,000 patterns). Advertisers do not operate their own foundry or make their own patterns. The successful applicant must be clerically minded and have an aptitude for keeping accurate records. Give full particulars, age, and wages required, to: Box 310, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WORKING Deputy Foreman, general foundry, South. Permanency first-class man. State full experience, salary, etc.—Box 302, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TENDER

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

THE Metropolitan Water Board invite Tenders for the supply of the undermentioned stores and services for the period of twelve months commencing June 1, 1937.

Contract No.

1.—Bricks, firebricks, cement, etc.
8.—Iron and steel.
9.—Bolts and nuts, screws, files, shovels, steam tubes, etc.
12.—Fuel oil, oil (lubricating), kerosene, motor spirit, greases, etc.
19.—Iron, brass, gunmetal and other castings.
20.—G.M. stopcocks and ferrules, outlets and caps for fire hydrants.
22.—Timber (hard woods).
23.—Maintenance of weighing machines.

Tenders must be submitted on the official forms, which may be obtained on and after Wednesday, March 17, 1937, from the Chief Engineer, by personal application at the offices of the Board (Room 171), or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board, and endorsed in the manner indicated in the Form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 o'clock Noon on Monday, April 5, 1937.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue,
E.C.1
March 10, 1937.

MACHINERY

WANTED.—Rotary Furnace of Brackelsberg type or similar, suitable for melting 1½ tons per hr.; either coal or oil fired.—Box 294, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone 98 Staines.

AIR Receiver, 18 ft. 6 in. by 4 ft. 6 in.
Horizontal Compressor, 200 cub. ft. at 100 lbs.
8-in. Root's Blower (as new), 5 lbs. pressure.
Vertical Boiler, 8 ft. 6 in. by 3 ft. 6in., 80 lbs.

HARRY H. GARDAM & CO., LTD.,
STAINES.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

WARLINGHAM PARK HOSPITAL, UPPER WARLINGHAM, SURREY.—The Committee of Visitors invite offers for the following:—One cast-iron single-fire Smith Hearth, 3 ft. 6 in. by 3 ft. 6 in., complete with C.I. Hood and Water Bosh, movable gaps and back blast. One double-acting Leather Bellows, 2 ft. 6 in. diameter. Both the Hearth and the Bellows may be inspected at the Hospital between the hours of 9 a.m. and 1 p.m. and 2.30 p.m. to 5 p.m. The purchaser will be required to arrange for the removal of the equipment. Estimates addressed to the Clerk and Steward, Warlingham Park Hospital, Upper Warlingham, Surrey, must be returned not later than Tuesday, April 6, 1937.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO., LTD., Station Works, Ecclesfield, Sheffield.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.
EXHAUST FANS (large stock), electrical and belt driven.
ELECTRIC RUNWAY LIFTING BLOCKS:
One 4½-ton 460 volts d.c., Vaughan.
Two 2-ton ditto, Morris.
One ½-ton 220 volts d.c., Morris (as new).
One ½-ton 3/50/440 volts, Aabacas.
Two Reavell Rotary Compressors, 12 lbs. sq. in. pressure; 750 cub. ft. direct-coupled on bedplate to 60 h.p. S.R., 3/50/400 volts motor.
½-cwt. Pilkington Self-contained Pneumatic Hammer.
Geared Foundry Ladles, 9, 4, 3½, 2½ and 1 ton, etc.
AIR COMPRESSORS: 30 in stock in sizes 500 to 20 cub. ft.
ELECTRIC MOTORS: Large stock to suit almost all electric systems.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.
FOR ECONOMY — EFFICIENCY — GENERAL UTILITY.
"FORWARD" FOUNDRY SAND RIDDLE.
Capacity approximately 5 tons of foundry sand per hr. Self-contained. Drive from ½-h.p. totally-enclosed Motor. All working parts fitted Ball Bearings; provided with dust guards. 22" dia. Sieve can be removed and replaced instantly. Tubular Tripod with shoes.
Price, with A.C. or D.C. Motor, standard voltage, £25 10s.
Write for "Albion" Catalogue.
Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

FOR SALE.—Pneumatic Jarring Turnover and Pattern Draw Moulding Machines, No. 6 Ajax, No. 9 Ajax take 45 in. by 36 in. by 16 in. boxes. No. 12 Ajax, size of table 76 in. by 60 in., 18 in. pattern draw. Three Hand Moulding Machines by Darling & Sellars. The above machines are for immediate disposal in order to save storage, and are in good condition. May be inspected Yorkshire, West Riding.—Write Box 280, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS

QUOTATIONS wanted for Aluminium Pressure Castings, 21 in. by 5 in. (1¼ lbs.), in lots of 20,000.—Box 306, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TO SCRAP IRON MERCHANTS.

THE Norwich Corporation have for disposal about 60 tons of good Scrap Cast Iron and about 15 tons of Scrap Steel in two tandem suction gas engines and suction gas plant at their Trowse Sewage Pumping Station. The engines and gas plant are to be dismantled by the purchaser.

Forms of Tender and full particulars may be obtained on application to the City Engineer, Guildhall, Norwich, to whom Tenders on the forms supplied must be delivered not later than 10 a.m. on Monday, April 12, 1937.

'Phone: 287 SLOUGH

SEVERAL Good Foundry Grinders, Price, £5 to £20.

12' square Sand Blast Room Plant complete and in good condition. Price, £180.

Four Morgan Oil-fired Tilting Furnaces reconditioned — 450-lbs. capacity. Also 250-lbs. and 600-lbs. capacity in stock. CHEAP.

Large stock of Moulding Machines, Compressors and A.C. Motors.

PLEASE SEND US YOUR ENQUIRIES.

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!

SELECT YOUR MACHINE FROM THE LARGEST STOCK OF HIGH-CLASS SECONDHAND MOULDING MACHINES IN THE WORLD

Practical Advice Free

C. W. COLEMAN,
156, STRAND, LONDON, W.C.2.

(Small advertisements continued on opposite page.)